VOLUME 85, No. 5

STEAM GENERATION
POWER GENERATION
WATER POWER
DIESEL & GAS ENGINES
AIR CONDITIONING & HEATING
REFRIGERATION
PUMPS & COMPRESSORS
STEAM SERVICES
ELECTRICITY & ELEVATORS
INSTRUMENTS & CONTROL
PIPING SYSTEMS
MECHANICAL TRANSMISSION
POWER MISCELLANY

POWER

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MAY, 1941

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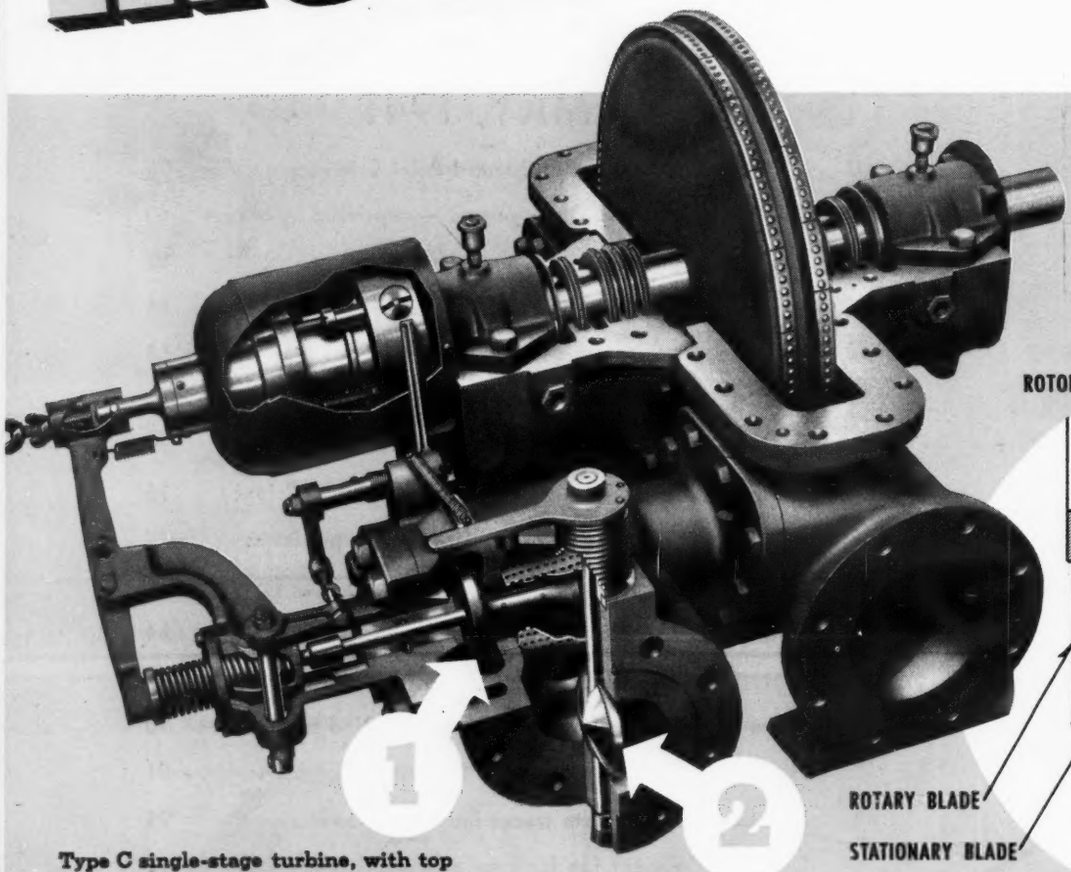
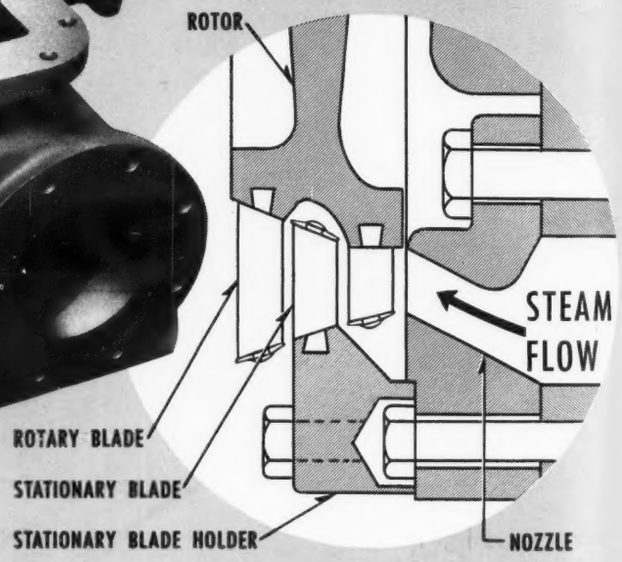
most turbine



Type C single-stage turbine, with top of casing removed. Cutaway shows Dual Protection overspeed trip linkage, which actuates *both* the governor valve (1) and the butterfly valve (2) at the *same time*, when overspeed occurs.

See how the steam path is contoured for maximum efficiency. Blade pitch is uniform. Blade shrouding is made conical to approximate the steam expansion characteristic. Nozzle dimensions are accurate.



ONLY WESTINGHOUSE TURBINES HAVE *ALL* THESE FEATURES:

- DUAL PROTECTION—Overspeeding trips both valves at once.
- Sparkless overspeed trip, with Micarta insert, when required.
- SHAFT PROTECTION—Sprayed with high chrome-nickel steel at the gland zones.
- Generous number of carbon rings.
- One-piece disc, shrunk and keyed onto shaft. Protected by corrosion-resistant paint.
- Rotor balanced dynamically.
- Chrome-alloy blades.
- Shrouding secured by spun blade tenons.
- Steam path contoured for efficiency.
- Heavy-duty hand valve with bolted bonnet.
- Powerful, sensitive governor.
- Cored water chambers for oil cooling.
- No soft packing on the inlet valve stem.
- Steam strainer about inlet valve.
- Heavy construction.
- Ground horizontal joint—no gasket.
- High-temperature aluminum finish.

Westinghouse

POWER

Established 1882 • PHILIP W SWAIN, Editor

ONE HUNDRED DAYS

The next hundred days may well be the most critical in the history of the world. As in Napoleon's hundred days of 1815, from Elba to Waterloo, a madman bent on domination has swept away the peace of our world. We are about to be drawn into the conflict, about to be forced to defend our principles and beliefs with every ounce of our strength.

We may as well face the obvious and admit that ill-equipped though we may be, this is going to be about all the equipment we have available for the test, all the resources upon which we can draw; except for our own spirit, resourcefulness and ingenuity.

It therefore is high time that we, individually and as a nation, took stock. Just what do we have available? Let us not speak now of guns and other weapons, which we still can produce, but of our power and production facilities. More specifically, let's take stock of our *power* facilities for the struggle that is to come, for that capacity is far more important than guns or battleships.

Authorities have said that America's productive capacity is *two and a half times* that of continental Europe, always assuming, of course, that there is an unfailing supply of power to that capacity. That's our job—to provide an unfailing source of power in every power plant of the nation.

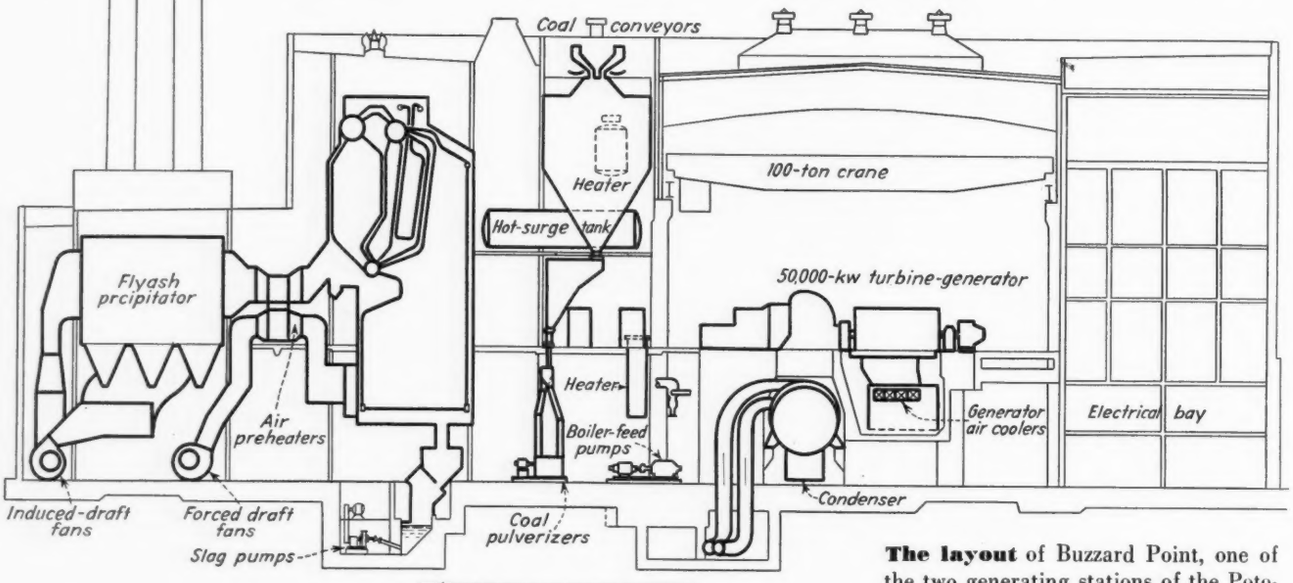
So—take stock. Is every unit in your plant in best possible condition? Are joints tight, packings dependable, accessories in working order? Should some spare hour be used now to make some changes or do a maintenance job on major units? Can something further be done to save the kilowatts *after* they leave your busbars, the Btu's *after* they leave your headers?

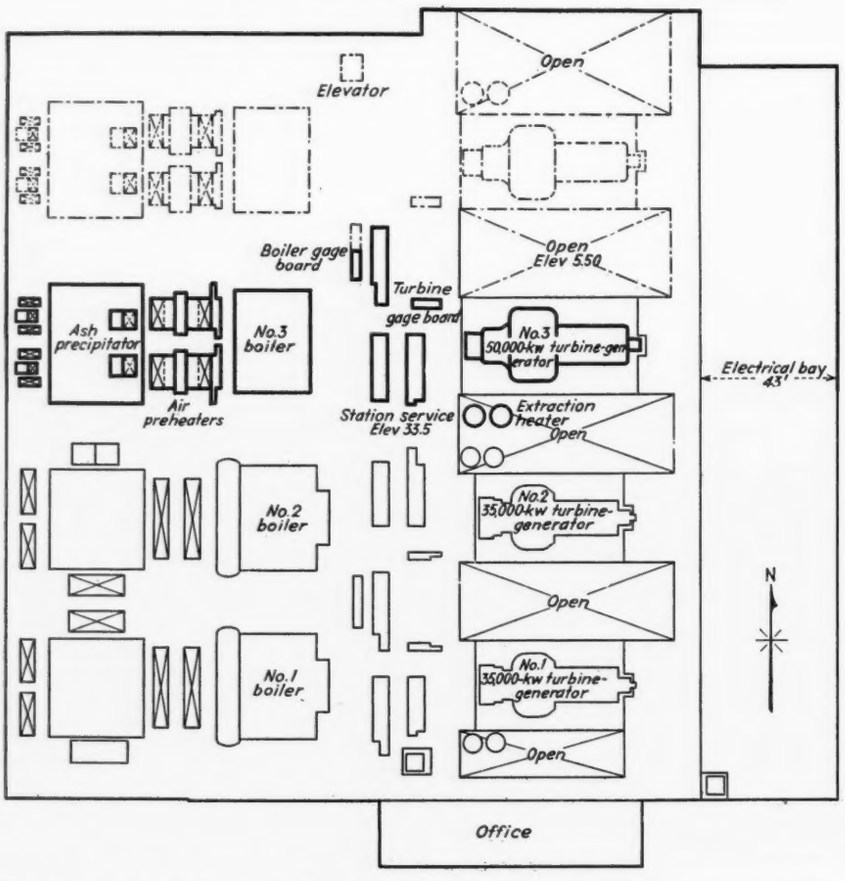
If so, it had best be done at once, for we are not yet at the "all-out" point when no time can be spared to nurse limping equipment, when any little failure may be the missing horseshoe nail that starts a disastrous chain of major failures.

We have perhaps ten, perhaps a hundred, days left. It behooves us all to make the best possible use of them, beginning *now!* For the succeeding hundred days may be *more* vital, and the hundred days after that even more crucial.

Coal Handling at Buzzard Point

50,000-kw addition to Potomac Electric Power Co station includes storage facilities for 70,000 tons of coal. Fuel-handling system for collecting and returning coal dust to bunkers described by M W Carty, Stone & Webster Engineering Corp





The layout of Buzzard Point, one of the two generating stations of the Potomac Electric Power Co, includes two 35,000-kw turbine-generators and a 50,000-kw unit (No. 3) placed in service in October, 1940. Combined installed capacity of Buzzard Point and Benning, both on the Anacostia River in Washington, D. C., is 305,000 kw. In addition, there is a high-tension transmission line to Baltimore, Md., for interchange of power.

The new unit is supplied by a single boiler having a capacity of 525,000 lb of steam per hr. Recent additions also include a new condensing-water intake tunnel and extensive new equipment for coal storage at ground level, all in accordance with previous planning.

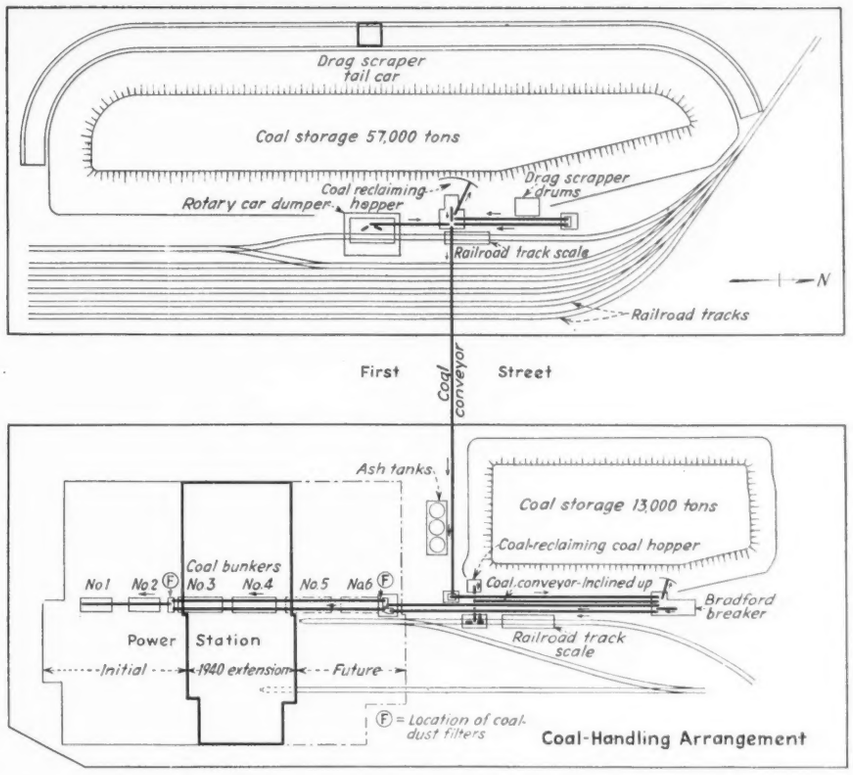
The power-station building has been constructed with space for still another turbine-generator (No. 4) and its boiler, which are now being installed. Buzzard Point is built on the unit principle of arrangement (see above), with each turbine supplied ordinarily only by its corresponding boiler. However, crossover piping permits complete flexibility in using steam from the several boilers when necessary. Steam pressure in the recent extension is the same as for earlier units, that is, 650 lb at the turbine throttle, but the 900-F steam temperature is somewhat higher than for the first two units.

Heat balance for the new turbine (see front cover of this issue) util-

Equipment in the extension is of about the same type as in the present station, but the boiler is a bent-tube unit, with tangential corner firing and continuous slag-drip furnace. High-pressure piping for the extension is all-welded with valves solidly welded in the lines, in accord with modern practice.

Extension

izes three direct-contact feedwater heaters in series and a fourth heater of the closed type in the discharge from the boiler-feed pumps. Final feed temperature is 375 F at full load. Computed heat rate for the new 50,000-kw turbine unit is 10,000 Btu per kwhr net generated at full load with a backpressure of 1 in. mercury.



Coal-Handling Arrangement

The new coal-handling arrangement has been planned to meet the requirements of an ultimate station of six turbine-generators. The original equipment, east of First Street, has been largely retained and the coal storage in this area is 13,000 tons. On the west side of the street there are 57,000 tons in a solid flat pile unbroken by valleys, which is most favorable to avoid carry-off of coal by wind eddies. As an additional precaution, an asphalt emulsion has been sprayed on the pile to reduce loss and to prevent washing away or spreading of coal at the base.

Total storage of 70,000 tons is expected to assure adequate supply at all times, even during periods of possible interrupted shipments from the mines. Coal comes to the station in railroad cars and sometimes, due to delays at the mines and in transit, cars accumulate. Railroad tracks are in the street, making it necessary to move the cars and unload them promptly. To meet these requirements, trackage for 50 cars has been provided within the power-station lot.

A rotary car dumper unloads coal at the plant. Reliability of supply to station bunkers is assured because there are two independent car-unloading setups, one west of First Street, a rotary dumper, the other east of First Street, a depressed track hopper. Two separate belt conveyors run to the station. Similarly, storage and reclamation of coal can be accomplished independently east and west of First Street.

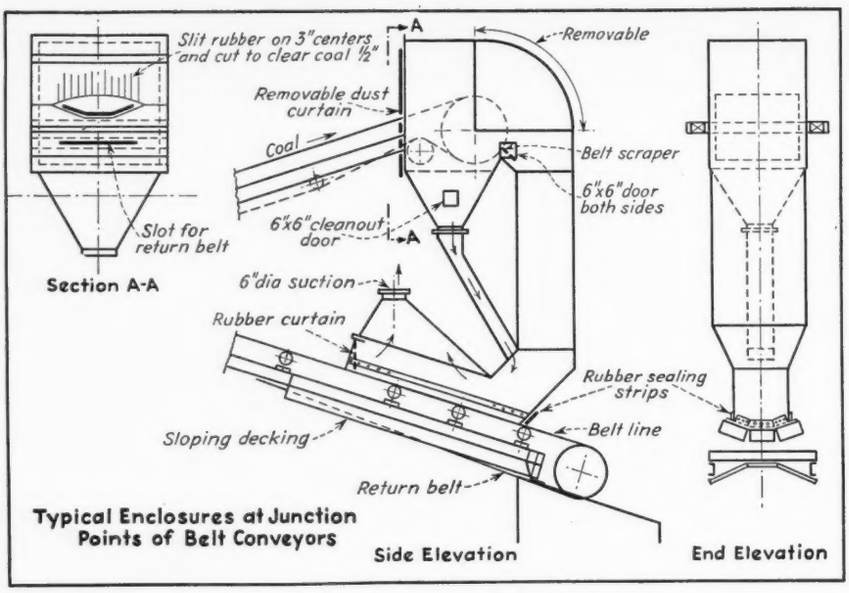
Coal is handled into and out of the ground storage area east of First Street by a drag scraper which has a 6-ton-capacity shovel capable of moving 300 tons per hr in this service when operating a distance of 250 ft. The tail car and drag shovel are remote-controlled from a position above the rotary-car-dumper house and therefore near the reclaiming hopper.

Usual coal is $\frac{5}{8}$-in. or $\frac{3}{4}$-in. slack, very dry and requiring provision for preventing escape of dust. Coal is unloaded and conveyed to the bunkers at 500 tons per hr. Cars are emptied within an unloading house after rolling steel doors at the ends are closed. Rising dust is drawn off with 20,000 cfm of air through a bag filter by a suitable exhauster fan. The house is completely clear of coal dust by the time the end doors are opened to permit spotting the next loaded car.

CONTINUED ON NEXT PAGE

Hoods at junction points of the belt conveyors, where coal is delivered from one run to another, prevent escape of dust. A typical enclosure is shown above. Hoods are provided above the skirtboards and a suction inward is created. Approximately 1500 cfm are drawn from each suction hood through bag filters to affect the desired slight inward flow of air.

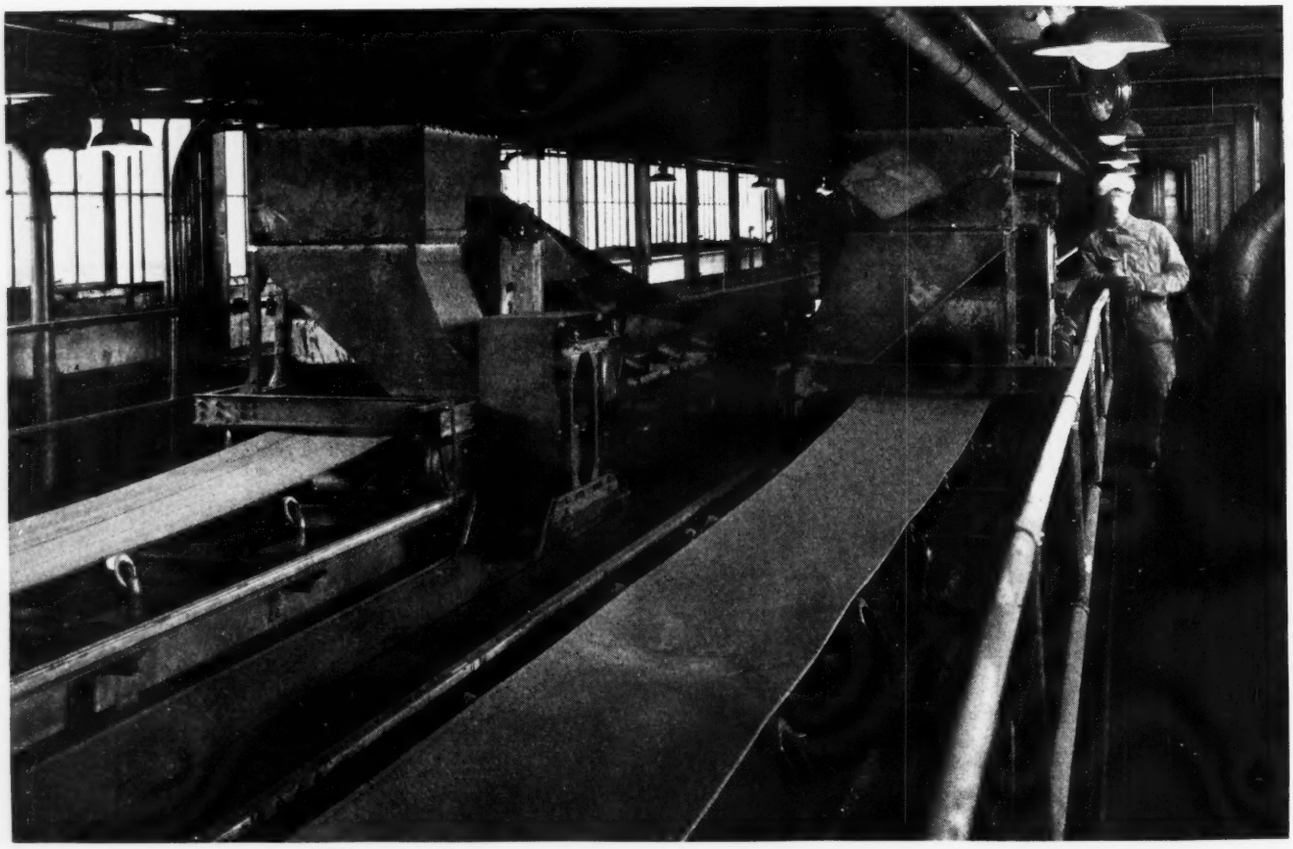
The coal-dust collecting system was planned in the expectation that only a relatively small proportion of the total dust in the coal as received would happen to come out at the car dumper and at the junctions of the belt-conveyor system. It would, therefore, be permissible to return the dust intermittently into the moving coal stream and consider it as mixing with the much greater quantity of fines remaining in the coal. Results in actual operation have shown that this arrangement is satisfactory.



Typical Enclosures at Junction Points of Belt Conveyors

The coal-dust filter on the west side of First Street delivers to the conveyor leading from there to the east side and, at the head end of the conveyor, a suction head disposes dust practically into the power-station bunkers. The objective is to cause such coal dust as may lie on top of the moving coal coming from the west side to take the shortest path to the station rather than to continue farther along the belt-conveyor system.

The collecting system was installed at reasonable capital investment. It greatly reduces annoyance from coal dust blowing around at the car-unloading point and from the junctions of the belt conveyors. Some sifting of coal takes place (as expected) at the lower ends of the skirt-board enclosures, but this is disposed of from time to time by a conveniently arranged vacuum collecting system which discharges into the coal bunkers.



The dust problem at the bunkers is met by sealing the top with steel plates, but leaving two narrow slots about 12 in. wide through which the traveling trippers discharge. These slots are each sealed by a strip of belt (see above) which lies flat on grating, except where lifted immediately at the tripper to permit discharge of coal. Approximately 2000 cfm of air are drawn from No. 3 coal bunker, which is enough to compensate for the displace-

ment by coal and to create a slight inward suction to prevent escape of dust.

Sealing the coal bunker makes conditions more comfortable for operators and reduces the potential hazard of starting fires or explosions in the bunker from external sources. Although explosions have occurred in bunkers storing pulverized coal, they have not been experienced in raw-coal bunkers. Nevertheless, a concentration of through-200-mesh dust, amounting to about 0.05 oz of semibituminous coal per cu ft of air, is sufficient to spread flames, and precautions against explosion are justified.

The power-station substructure consists of a heavy concrete mat which distributes the load. The lower portion of the walls is precast artificial stone, the upper portion light-colored brick with suitable trim, continuing the attractive features of the present station.

Main oil circuit breakers are of 1,000,000-kva rupturing capacity; bus-sectionalizing reactors with breakers are installed between the existing buses and the new extension. Differential relays are provided for protection against bus faults. The 13-kv oil circuit breakers and buses are in masonry structures and the 2,300-v and 440-v switchgear is of the metal-clad type. Suitable walls and openings have been provided to prevent spread of fire. All the planning has kept in mind still further extension of the station for six units in all, with an ultimate capacity of 270,000 kw.

Principal New Power-Plant Equipment—Unit No. 3

Buzzard Point Plant of Potomac Electric Power Co, Washington, D. C.

Fuel-Handling and Firing Equipment:

Storage capacity, 70,000 tons, drag power shovels..Beaumont Birch Co
Rotary car unloader.....Link-Belt Co
Belt conveyors, 500 tons per hr to bunkers..Robins Conveying Belt Co
Conveyor belts.....Boston Woven Hose & Rubber Co
Coal crusher for sampler.....Sturtevant Mill Co
Coal sampler, Geary-Jennings.....The Galigher Co
Bradford coal breaker, 9 ft dia x 17 ft.....Pennsylvania Crusher Co
Flyash vacuum air transport and separating system
United Conveyor Corp
Slag and ash-storage tanks.....Allen-Sherman-Hoff Co
Slag pumps and piping.....Allen-Sherman-Hoff Co
Coal pulverizers, three Atrita units.....Riley Stoker Corp.
No. 5 A duplex. 250-hp motor, 900 rpm
Coal feeders, 6 shelf-cleaning drum type.....Riley Stoker Corp
Coal burners, 12, 3 per corner, tangential firing.Combustion Engrg Corp
Forced-draft fans, 2, double-inlet.....American Blower Corp
Capacity 78,750 cfm each, 9.4 in. static pressure, 150-hp constant-speed motor, 1200 rpm, adjustable-inlet-vane control
Induced-draft fans, 2, double-inlet.....American Blower Corp
Capacity 152,000 cfm each, 15.2 in. static pressure, 600-hp, 900-rpm, constant-speed motor with hydraulic coupling
Flyash precipitator, 265,000 cfm, Cottrell.....Research Corp
3 units wide, 3 sections deep, Cottrell plates 6 ft, 5 in. wide, 17 ft, 6 in. high, 2 in. thick with 3/8-in. rod-embedded electrodes, 75,000 volts, to remove 96% of suspended matter
Chimney (for No. 3 boiler and for future No. 4 boiler).Rust Engrg Co
Radial brick, 15 ft 9 1/4 in. dia at top, 159 ft 6 in. high
Railroad track scales.....Howe Scale Co
Coal weigh scales, 400-lb capacity.....Richardson Scale Co
Belt weightometers.....Merrick Scale Mfg Co
Coal-dust removal equipment.....W W Sly Mfg Co
At rotary car dumper, belt-conveyor junctions, and No. 3 coal bunker

Steam-Generating Equipment:

Boiler, 3-drum, bent tube.....Combustion Engrg Co
Capacity 525,000 lb per hr, 66-in. steam drum, 17,150 sq ft heating surface, 775 lb max design pressure, water walls, 25,600 cu ft furnace volume
Superheater, Elesco multi-loop.....Combustion Engrg Co
900 F, 14,800 sq ft heating surface, temperature control by bypass dampers in top of 2nd pass of boiler
Economizer, Elesco, continuous loop.....Combustion Engrg Co
2 in. od tubes, 13,780 sq ft heating surface
Air preheaters, two Ljungstrom.....Air Preheater Co
Horizontal-shaft, regenerative type, each with 25,800 sq ft heating surface, 530 F final air temperature
Safety valves.....Crosby Steam Gage & Valve Co
Blow-off valves, type B, rotary.....Cochrane Corp
Soot blowers.....Diamond Power Specialty Co
Water columns.....Diamond Power Specialty Co
Boiler-feedwater regulators, 2, Flowmatic (Copes)
Northern Equipment Co

Power-Generating Equipment:

Turbine-generator, 50,000 kw.....General Electric Co
17 stage, 1800 rpm, steam rate extraction operation 8.48 lb per kwhr. Generator: 3 phase, 60 cycles, 13,800 volts, 0.85 pf. Direct-connected 175-kw exciter with pilot exciter
Condenser, horizontal, single pass..Worthington Pump and Mach Corp
Reheating hotwell 41,000 sq ft surface, steam jet air removal
Admiralty tubes rolled at both ends { Phelps-Dodge Copper Products / Scovill Mfg Co
Extraction heaters.....Foster Wheeler Corp
3 open, 1 closed. Direct-contact rain-type. Receive steam from 8th, 11th, and 14th stages. Capacity 502,300 lb water per hr. One closed tubular type receives steam from 5th stage
Evaporator, 1 high pressure, single effect.....Foster Wheeler Corp
Submerged coil type, 10,000 lb per hr steam from 8th stage
Evaporator condenser, 1 vertical,.....Foster Wheeler Corp
2-pass, straight-tube, closed, floating head
Evaporator deaerating feedwater heater.....Foster Wheeler Corp
Open-tray type within evaporator shell
Oil coolers, 2 vertical.....Schutte & Koerting Co
Generator air coolers, 1,980 sq ft.....General Electric Co
Internal wetted surface, 95,000 cfm from 140.6 to 96.2 F, 1100 gpm cooling water

Pumps

Boiler-feed pumps, 3, single suction, 7-stage.....Ingersoll-Rand Co
575,000 lb per hr, 900-lb pressure. 2 motor driven (800-hp each), 1 turbine driven
Boiler-feed-pump drive turbine.....Terry Steam Turbine Co
Circulating-water pumps, 2 each..Worthington Pump and Mach Corp
37,000 gpm, 300 gpm, 250-hp, 2300-volt induction-motor drive
Condensate pumps, 2800 gpm.....Worthington Pump and Mach Corp
134 ft discharge head, 900-rpm, 60-hp, 2300-volt induction motor
Condensate booster pumps, 2 duplex units.....Ingersoll-Rand Co
Horizontal, centrifugal each 495,000 lb, 2300-volt induction motor
River-water pumps, 2, 3500 gpm.....Ingersoll-Rand Co
Cooling-water pumps for generator air, 3200 gpm..Ingersoll-Rand Co
Distilled-water pump, 150 gpm.....Ingersoll-Rand Co
Evaporator feed pump, 75 gpm.....Ingersoll-Rand Co
Intake screen-well pump, 600 gpm.....Ingersoll-Rand Co
Oil-transfer pump, rotary type.....S F Bowser & Co

Tanks

Distilled-water storage, 20,345 gal.....J E Hurley
Distilled-water, cold surge, 5340 gal.....J E Hurley
Distilled-water, hot surge, 7400 gal.....Foster Wheeler Corp
Fuel-oil tank for starting boiler and ignition, 10,000 gal
Graver Tank & Mfg Co

Instruments

Boiler meters, steam flow, air flow, feedwater.....Bailey Meter Co
Boiler-feedwater Venturi meters.....Builders Iron Foundry
Indicating pressure gages.....Star Brass Mfg Co
Recording and dial type indicating thermometers.....Foxboro Co
Recording pressure gages.....Bristol Co
Draft gages.....Hays Corp
CO_2 recorder.....Hays Corp
Indicating glass stem thermometers.....C J Tagliabue Mfg Co
Smoke-density recorder.....Bailey Meter Co
Combustion control.....Hagan Corp

Pipe, Fittings and Valves

Gate valves, high-pressure steam, 730 lb, 900 F.Chapman Valve Mfg Co
Gate valves, high-pressure water, 1030 lb, 380 F.Chapman Valve Mfg Co
High-pressure steam and boiler-feed piping.....Benjamin F Shaw Co
Boiler non-return valves.....Wm Powell Co
Globe valves.....Wm Powell Co
Globe valves, small size.....Crane Co
Check valves.....Wm Powell Co

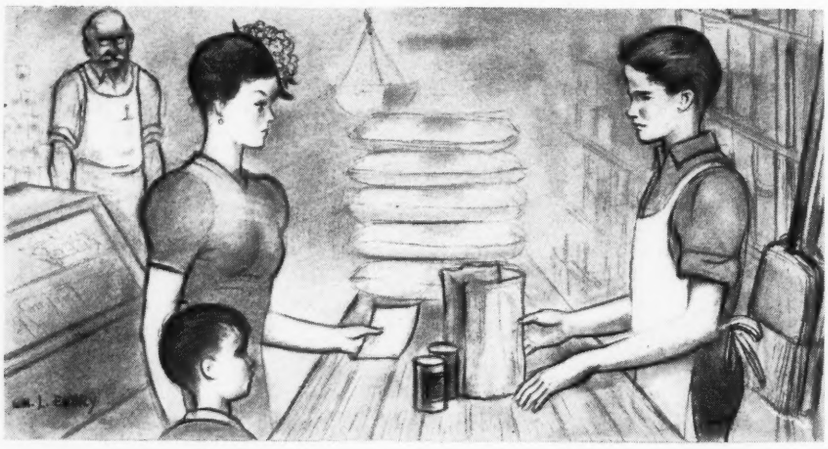
Miscellaneous

Condensing water traveling intake screen.....Link-Belt Co
10 ft wide 26 ft deep
Turbine-oil purifier.....S F Bowser & Co
Water filters, two, each 25 gpm.....Hungerford & Terry, Inc
Steel-plate air ducts.....Lorensen Matthews Mfg Co
Heat insulation (Philip Carey material))
Asbestos Covering & Roofing Co
Coal-dust filters.....W W Sly Mfg Co
At rotary car dumper and for nearby belt-conveyor junctions, 9636 sq ft cloth with fan exhauster, 26,500 cfm, 9 in. wg static pressure. At belt conveyor junctions near Bradford coal breakers, 1848 sq ft cloth with fan exhauster, 3900 cfm, 7 in. wg static pressure. At top of inclined belt conveyors to power-station bunkers, 1980 sq ft cloth with fan exhauster, 3900 cfm, 8 in. wg static pressure. At coal bunker, 1230 sq ft cloth with fan exhauster, 3696 cfm, 7 in. wg static pressure
Vacuum cleaning system.....Spencer Turbine Co
Extending to rotary car-dumper pit and pits at belt-conveyor junctions

"So You Want to be an Engineer"

Does your son want "to study to be an engineer," or do you know some high-school boy who seeks your advice? If so, you will be interested in this letter from a practising engineer to his nephew. Case and letter are real

This article, first published in March, 1938, POWER, is reprinted here in answer to numerous requests, and because today it is more timely than ever. It was first written by POWER'S editor, Phil Swain, as a letter of practical advice to his nephew.



"Spend a summer in the store and learn the simple things about everyday business"

"Dear Bill:

You will graduate from high school next June. Your father tells me you want to be an engineer (not just sure what kind), and asks me to advise you regarding your education and summer jobs. I am mighty glad to do this, because I think you have the ability to go places in engineering if you get the right start. For many years I have been thinking about this matter of job preparation and noticing which men got ahead and which didn't and why. I have discussed job training with many college professors and with successful engineers and business men.

"To get us right down to brass tacks, I have laid out the attached job-preparation chart, which sums up my own observations and convictions.

"No two men ever see things exactly alike, yet I feel, Bill, that the average engineer of long experience will admit that this chart is at least 80% right. Certainly all successful business men and engineers agree about the importance of getting along with people and of being able to express yourself successfully in writing and in speech.

"A few engineers, and many of the professors, might claim that I have overstressed the importance of picking up a lot of practical skills *before* graduating from engineering school. Yet the longer I live the more certain I become that certain elementary skills are as fundamentally useful as Ohm's law and the multiplication table, because they enter into every move the engineer makes in actual life.

"Don't get the idea that you can safely postpone some of these things until after you get your diploma. Did you ever hear of a great musician who confined himself to the theory of music in his early years and didn't start thumping the piano until he was 25? No, youth is the time to learn to play an instrument, to skate, swim, ride a horse, sail a boat, dance, get along with people, run a typewriter. I can't see any good reason why you should wait until after graduation before learning how to write a business letter, swing a hammer, push a file, sell a bill of goods or get along with a bunch of workmen.

Observe the Cat

"Before I explain how to use the job chart, I must deliver one more piece of advice, based on long experience and observation. You've probably read inspiring stories about men who start young preparing for one specific job. In general, I don't think it's a good plan, although there have been some spectacular exceptions. I'm not underestimating the importance of having a definite purpose in life but feel that too-early specialization is very dangerous. Observe the ways of the cat, Bill. She knows more than one way to jump. Her outstanding talent is the ability to land on four feet under any circumstances.

"To be safe you've got to be versatile. How many men today are actually in the jobs they picked for themselves 20 or 30 years ago? How can you be sure about what you will be doing in 1958? When that day arrives, the job you planned may not even exist, or the rapidly changing world may have created a new, and much better, opportunity for you somewhere else. There is always a lot of chance and uncertainty in human affairs. Above all things, prepare yourself to land on four feet no matter where you are tossed. That means being able to do those simple everyday things that enter into all jobs.

"I hope you get this point, because it is important. Don't decide right now that you are going to be an air-conditioning engineer or a diesel engineer. Train yourself in the general fundamentals of mechanical and electrical engineering. At the same time acquire some skill in the simple everyday operations of all engineering and business occupations. I repeat, start right now learning how to talk and write English, work with people, sell, handle tools and machines, write business letters, keep simple accounts. Then you will be equipped to make a living with your hands and end as far up the line as your head, your adaptability, your energy and your good luck can carry you.

"It's about time I explained that job chart. The names at the top of the column indicate general classifications

FINAL JOB

PREPARATION AND BACKGROUND			Design	Engineering Selling	Factory (business end)	Factory (engrg. end)	Construction	Consulting engineer	Power engineer	Research
General Skills		Ability with people	1	1	1	1	1	1	1	1
		Writing ability	1	1	1	1	1	1	1	1
		Talking ability	1	1	1	1	1	1	1	1
Special Skills		Handling tools	1	2	2	1	1	1	1	1
		Speeches	2	1	1	1	2	1	2	2
		Writing letters	1	1	1	1	1	1	1	1
		Writing reports	1	1	1	1	1	1	1	1
		Bookkeeping	2	1	1	1	1	1	1	2
		Typing	2	2	2	2	2	2	2	2
		Freehand drawing	1	2	2	1	1	1	1	1
Field Experience (Summers)		Shop mechanic	1	2	2	1	2	1	1	1
		Construction	2	2	2	2	1	1	1	2
		Office	1	1	1	1	1	1	1	1
		Selling	1	1	1	1	1	1	1	1
		Drafting	1	2	2	1	1	1	1	1
College Studies		English	1	1	1	1	1	1	1	1
		Physics	1	2	2	1	1	1	1	1
		Chemistry	1	2	2	1	2	1	1	1
		Math	1	2	1	1	1	1	1	1
		Drafting	1	2	2	1	1	1	1	1
		Economics	2	1	1	1	1	1	1	1
		M.E. studies	1	2	2	1	1	1	1	1
		E.E. studies	1	2	2	1	1	1	1	1

of jobs. Starting with an engineering slant, you are almost certain to land in one of these classifications eventually, but it's hard to tell which at this distance. Therefore prepare, to some extent, for all of them.

"Down the left-hand side of the chart I have listed important elements in job preparation and background. These are grouped as *general skills, special skills, field experience,* and *college studies.* Every one of the listed items is part of the necessary preparation for some job or other. Most of them would be helpful in a hundred different jobs.

Rating the Values

"The next thing I did was to consider how much value each element in this imaginary preparation would have after you were well established (say 15 years from now) in any one of the general job classifications. I have rated a particular item of preparation *1* where you would find it essential or extremely important and 2 where it would be helpful, but less essential. You will better understand what I mean if you will look at the line *shop mechanic.* Early shop training has real value in any job you may later get, but it will be more important in some lines than others. I rate it 2 if you become a sales engineer and 1 if your final job is on the engineering side of factory work.

"To simplify matters, I have considered only the requirements of the advanced job. That is why, for example, I have listed sales experience and ability as a *number 1* requirement for engineering research. That might not seem to be necessary, but it will be if you ever become a research executive faced with the problem of 'selling' ideas to your staff and of 'selling' the financial heads of your company the necessity of an adequate research budget.

"If you will look through the various columns you will find that certain background elements, particularly the first three, are essential to success in any job you might get. Now isn't it common sense to equip yourself as soon as possible with those skills that will help you earn a living and move ahead no matter where you may land?

"You may not particularly admire the man who goes through life smoothly by shaking hands, writing smart letters and talking glibly, but the fact that it is done so often proves that these abilities have tremendous commercial value. Now your mind is constructive; a comfortable existence as a 'hot-air artist' wouldn't satisfy you. You propose to do useful things and know what you are talking about. Fine; you are in line to become a useful citizen! Nevertheless you must add the qualifications of a salesman to fundamental worthiness, if you expect to accomplish much, certainly so if you seek the maximum return in salary and recognition.

"What every salesman has is 'ability with people' listed under 'General Skills.' By this I mean the ability to win the friendly cooperation of all kinds of people, to get along with your boss, your equals and men under you, to get along with those to whom you sell and from whom you buy. No matter what title may be on your business card, you will find that life is largely *selling.*

"If the engineer cannot get other people to help him put his sound ideas into action, his technical knowledge has no commercial value and he himself will never be able to hold a good job, regardless of his engineering ability.

"When it comes to *writing ability,* I haven't in mind so much the writing of articles as the ability to write business letters, reports and notes that will put the recipient in the right frame of mind and get things done the way you want them. Bad letters and clumsy reports will get you nowhere fast. *Talking ability,* of course, includes the ability to keep your mouth shut at the right time. It might be defined as the ability to use spoken words (plus discreet silence) to make people think well of you and cooperate with you.

Summer Jobs

"There won't be enough summers between now and graduation from college for you to get extended experience in all the indicated fields. If you must choose, I suggest you spend at least one summer in a shop. Be sure to get some greasy job in overalls, running a machine, chipping castings, helping machinists or millwrights, oiling engines or something like that close to nature. Learn how men feel toward a boss, which qualities they like in him and which they don't. Learn how it would be wise for you to behave when you get to be a boss. Begin to get that 'shop sense,' for the lack of which some smart theoretical engineers suffer.

"It would be a good idea to spend one summer in a store. You might work in a hardware store, or you might deliver groceries. This will teach you the simple little things about everyday business, about keeping a lot of little details straight and keeping customers satisfied. Most important, it will initiate you into the mysteries of salesmanship.

"I could keep talking all night on this subject of job preparation, but I haven't the time and I guess you can get the idea from what I have said and from studying the chart. And though you've got some tough years ahead, there will be lots of fun, too, if you go at it right.

"Your uncle."

(A few reprints of the original article are available. While they last single copies will be sent, without cost, to readers who request them.—Editor.)

Old Boilers Air Condition Office Building

Architect's sketch of 10-story Kennedy Building, 27 years ago

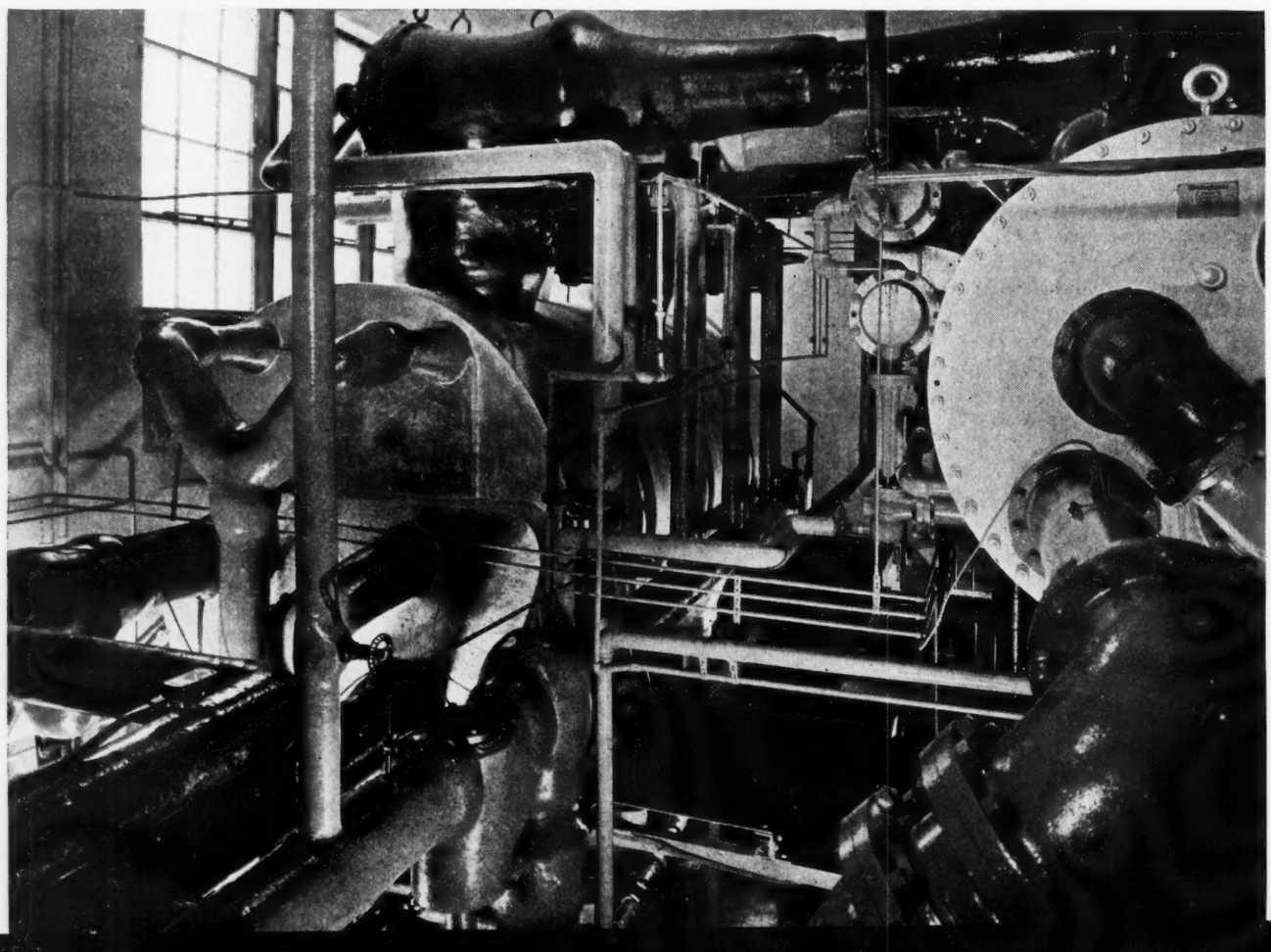
360 tons of steam-jet refrigeration using available excess boiler capacity forms heart of air-conditioning system providing summer cooling and dehumidifying, winter tempering and ventilation for 10-story Kennedy Bldg, Tulsa, Okla.

▶ UTILIZING AVAILABLE EXCESS BOILER capacity, a 360-ton steam-jet system provides summer cooling and dehumidifying and winter tempering and ventilation in the 10-story, 27-year-old Kennedy Building, Tulsa, Okla, at an operating cost only slightly above that for winter heating.

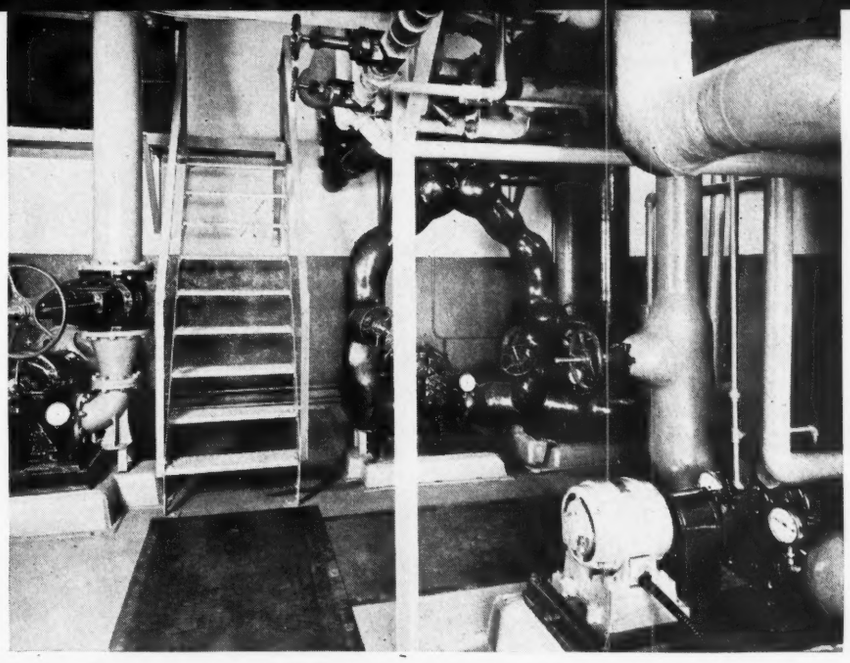
Of the existing four gas-fired high-pressure boilers (1500 sq ft each), only one is required for building heating. Therefore, the engineers decided to take advantage of the ample steam facilities to operate a steam-jet conditioning system. Equipment installed by Natkin & Co, Westinghouse air-conditioning distributors, includes an evaporating tank, four booster ejectors, and a surface condenser fitted with 1st- and 2nd-stage ejectors and inter- and after-condensers. Both evaporator and condenser are built for 2-stage operation, with two booster ejectors on each stage. Two of the four main ejectors operate under automatic control, responding to temperature difference in the chilled-water circuit, and two operate under manual control.

Boilers supply steam at 80 lb pressure and at a rate of 27 lb per hr per ton of refrigeration. Cooling water for the surface condenser comes from a cooling tower equipped with four forced-draft fans, each driven by a direct-connected 15-hp gear motor and having a total capacity of 360,000 cfm.

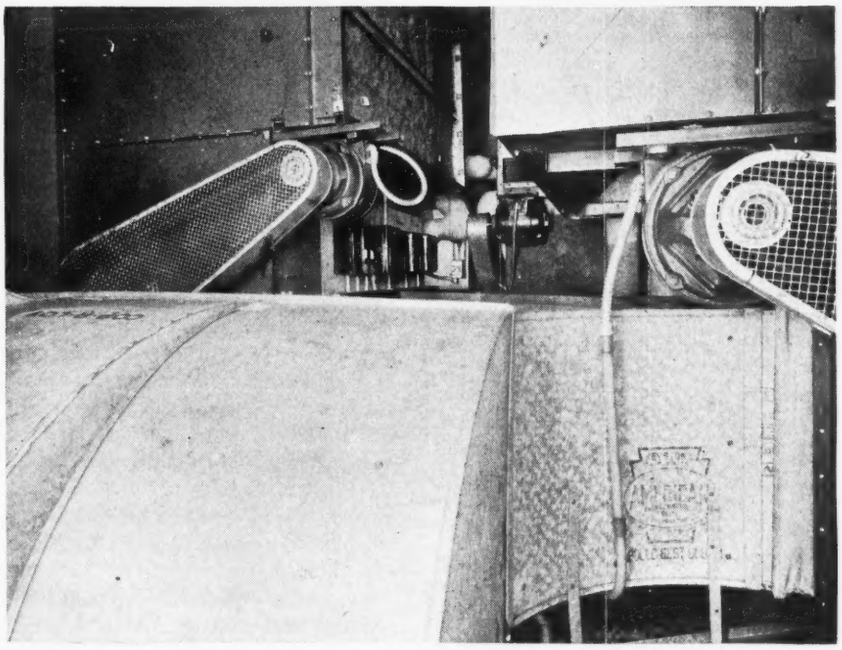
The system is thermostatically controlled to maintain 80 F dry bulb and 50% relative humidity. During the first season's operation about 3,500,000 cu ft of gas was consumed monthly, which was a little greater than that used in winter for heating the 420 office rooms and the first-floor and basement areas.



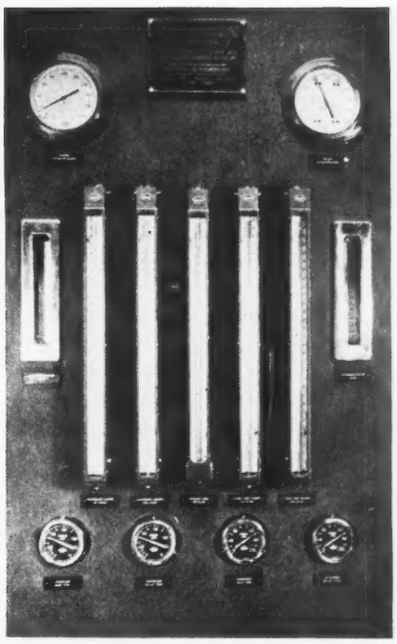
Upper level of steam-jet equipment—evaporating tank at left and surface condenser at right, with four booster ejectors between. Supplied with 80-lb boiler steam, the boosters maintain a vacuum in the evaporating chamber. At this low pressure, part of the water in the evaporating tank flashes into vapor, absorbing the necessary latent heat from the remaining water which is thereby chilled to the temperature desired for circulation in the air-conditioning system. The surface condenser handles vapor from the booster ejectors, sending it back to the boiler in the form of condensate



Chilled-water and condensate pumps at lower level of steam-jet equipment



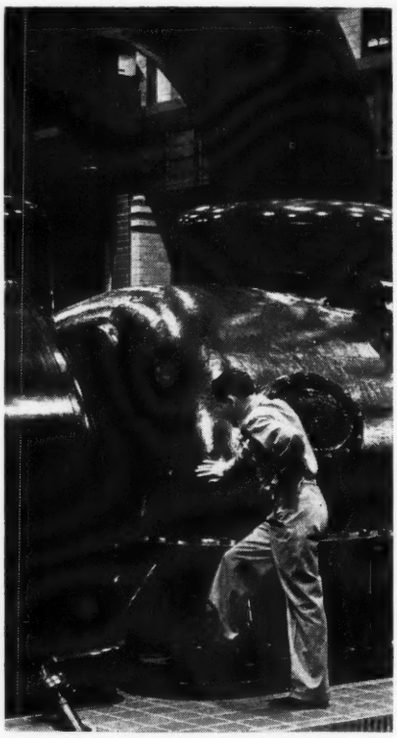
Chilled water circulates to six conditioner rooms, located in pairs on the 3rd, 6th, and 9th floors. Each room houses cooling and dehumidifying coils and spray nozzles for winter humidifying. Filters and fans complete the equipment



A complete panel board shows operating conditions at a glance. Indicating pressure gages show header and boiler pressure and flow of condensing and exchanger water; manometers give machine-room pressure and vacuum in the two stages of the condenser and evaporating tank; dial thermometers tell condenser and exchanger inlet and outlet temperatures

Treated air from the conditioner rooms enters a duct system concealed above furred ceilings in the corridors. Grilles replace the former transoms. This arrangement, in general, follows usual practice in fitting air-conditioning systems to existing buildings

Wanted— A New Turbine-Oil Test



Experience with turbine oils containing anti-oxidants plainly shows the need of a test to replace the neutral-number yardstick. The author here outlines the history of turbine-oil evaluation and shares the results of a test developed at Springdale Station

By M D BAKER
Chief Chemist, West Penn Power Co

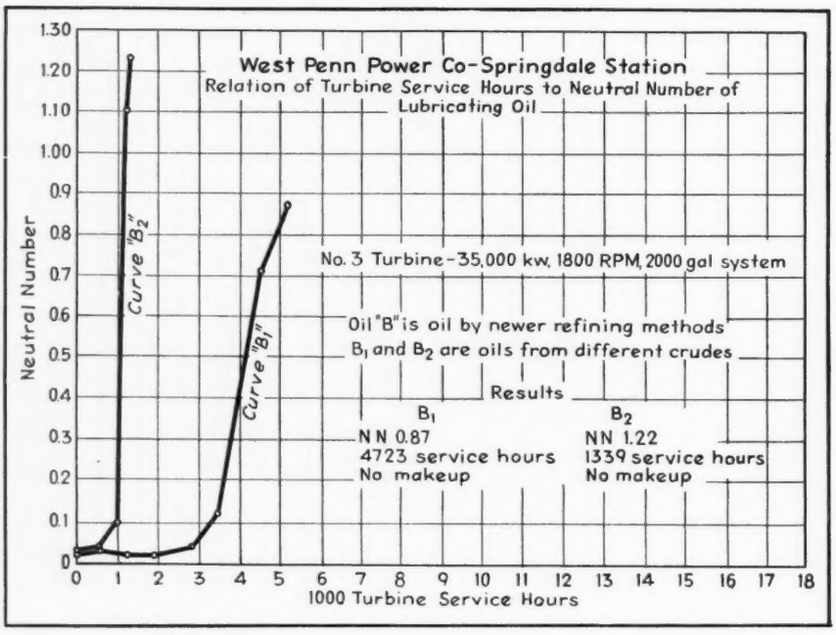
▶ SOME 15 YEARS AGO a distinctive method of selling was introduced by the salesmen of one of the large oil companies. When they called upon a customer, they displayed three or more sample bottles of oil, all but one of which had varying amounts of a black tarry-like sludge in the bottom. The one without the sludge was the superior product produced by their new method of refining. The other oils were comparable in proportion to the amount of sludge present; the larger the amount of sludge, the poorer the oil quality.

The interesting result of this method of selling was that in a short period of time other oil companies had similar displays, and claimed that their method of refining produced a better product and showed that the competitor's "superior" oil would produce a sludge when refined by the second company's method. These displays were of little value except to mark the period during which the various oil companies began to change their methods of refining.

Previous to that time turbine oils were apparently produced to meet certain physical tests, and only the progressive refiners endeavored to produce more stable oils by careful selection of crudes and closer supervision of refining methods. The short oil life generally experienced was not entirely due to the oil, because the design of the lubricating system was in many cases at fault; lubrication seemed to be a necessary evil in turbine design, so little attention was given to the oiling system. Short oil life and bearing failures were expected. Storerooms usually carried a complete set of bearings for each type of turbine.

Improvements have been made in oil refining, and more attention is being paid to the oiling systems in turbine design; the results are much longer service life from a carefully refined oil and very infrequent bearing failures. It may be said that the salesman with the little sample case marked the beginning of an era in lubrication.

Many attempts were made by users to extend the life of turbine oil in service. Two of the most frequently used were batching and sweetening. Batching was placing an oil in a unit for a definite period of time or until a certain predetermined neutral-number rise had developed. The oil was then removed and allowed to rest for a predetermined period. When placed in the rest tank, it may or may not have been agitated with water or heated to accelerate separation. While resting, some sludge settled out, and at times a small drop in neutral number occurred. The economy in this method of oil handling was questionable because of the excessive make-up requirements and the unit outages. After



several years this practice was discontinued.

Sweetening was the removal of a volume of oil at stated intervals, and replacing it with new oil, in an endeavor to maintain the oil in such a condition that it would never be necessary to replace an entire batch at one time. Experience showed that the volume required to sweeten an oil effectively was so great that the practice was uneconomical.

New problems were presented when refining methods changed and improvements were made in turbine design. The newer refined oils, compared to the older types, had a better record in their early life, but after a short period of stability they began to deteriorate and did so at a very rapid rate. It appeared that some ingredient had been removed in the changed refining process and the lack of this material caused the oil to break down.

Causes of Deterioration

Two basic related causes for this rapid deterioration were discovered. (1) At the beginning of a service period the new oils were more resistant to deterioration, but when oxidation started the rate was very rapid. (2) The new oils would dissolve old films of sludge and deposits coating the surfaces of the oil system. The clean metal surfaces thus exposed aided in deterioration by the formation of a metallic compound in the oil that accelerated the rate of oxidation. The reaction that occurred was termed "metal poisoning." Laboratory tests showed that copper and iron, both used in turbine lubricating systems, were active in causing this deterioration.

Further studies produced compounds that inhibited oxidation and metal poisoning. These inhibitors, usually termed "anti-oxidants," fall into two classes: (1) true anti-oxidants, compounds that retard the rate of oxidation; (2) precipitants, anti-oxidant compounds that also precipitate the metallic compounds from the oil. The precipitate deposits a very thin film on the surface of the metal, thus making the metal passive to further reaction with the oil. The precipitant, by a controlled procedure, makes the metal passive and produces the same result formerly accomplished by the gums and sludges which settled out of the older types of oil when in service. Davis, Lincoln, Byrket, and Jones,[1] and Reiff,[2] have published papers that ably discuss anti-oxidants.

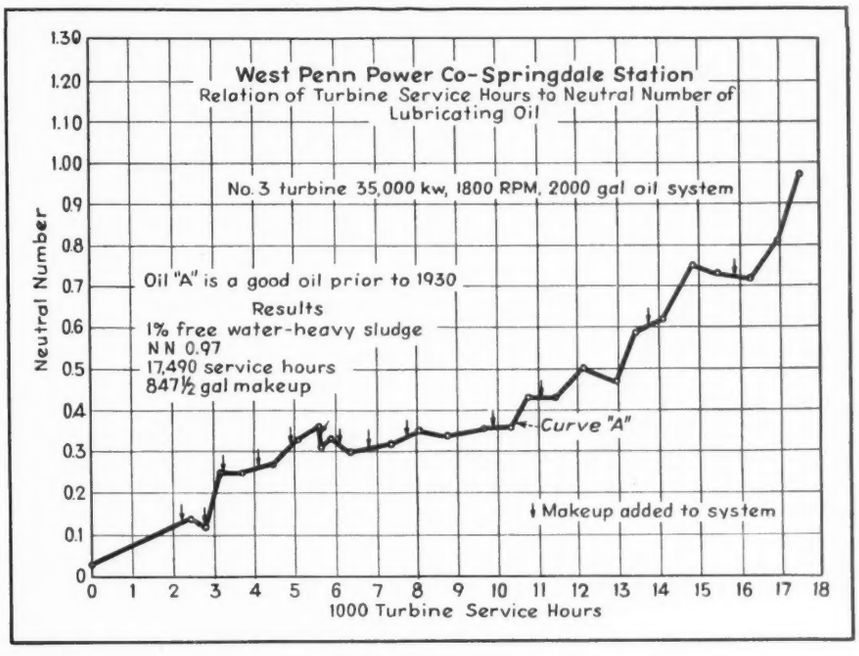
A serious problem that appears with the use of anti-oxidants in oil is the frequent occurrence of corrosion in oiling systems. Corrosion with the formation of ferric oxide (Fe_2O_3) has been experienced for years, but rarely was a case reported where it gravely interfered with turbine operation. Since highly refined oils and anti-oxidants have been introduced, corrosion that produced magnetic iron oxide (Fe_3O_4), as well as ferric oxide, has been reported quite frequently.

The magnetic oxide is in the form of dense, hard crystals, which are highly abrasive, and has a tendency to settle in locations of slow oil circulation. Corrosion usually occurs shortly after starting a new unit, and the first serious trouble experienced is the failure of the governor mechanism to operate. Corrosion and corrosion products have been present in amounts sufficient to prevent the spinner on the governor from operating, and can be formed in the presence of small amounts of water, 0.1% or less.

The need for accurate methods to determine the condition of an oil in service, which would enable the user to tell when it can safely be used or when it should be discarded, has long been recognized. Many tests have been made or recommended for this purpose. Viscosity tests were of some value when using a blended oil, as the lighter fractions would volatilize and the heavier remaining fractions had higher viscosities. When the viscosity increased to a certain predetermined figure, the oil was discarded.

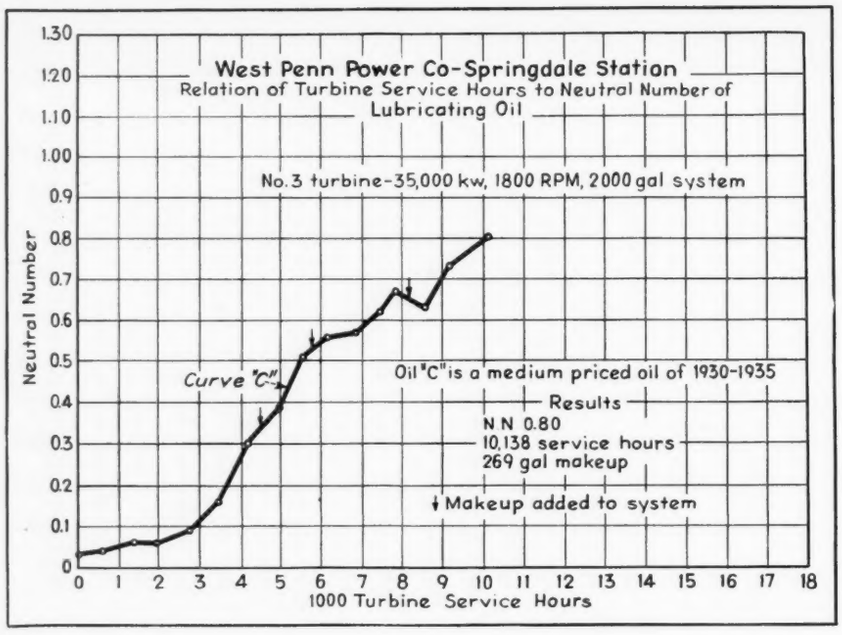
Another very simple test that had merit was the collection of a series of samples at stated intervals, one at each sample period. The samples were allowed to stand and were observed for the amount of sludge that settled in the bottom of the bottle. The uncertainty of this test was not knowing the amount of sludge which was harmful, nor how long a unit could be operated safely when some sludge was present.

Numerous other tests have been used and new ones are constantly being suggested. Some have a degree of popularity, largely because of the publicity given them, but rarely are they of any practical value to a control laboratory. The most commonly accepted and universally understood test is the *neutral number*, sometimes termed neutral value or acid content. The number is expressed in milligrams of potassium hydroxide required to neutralize one gram of oil. The exact procedure to follow in making this test is still undetermined. The present generally accepted method has been an ASTM tentative standard since 1927. This year another revision that does not materially alter the method is being offered.



In service, the increase in neutral number in the older types of oils was very definite. The neutral numbers, when plotted in a curve against time, might have a saw tooth effect, but the over-all trend was definitely up and proceeded at an accelerated rate. A study of a series of tests made at stated intervals aided in determining the useful life of an oil and made it possible to predict when it should economically be replaced.

Experience with oils in systems in which there was practically no water contamination showed that any water contamination would produce a heavy sludge when the neutral number was


West Penn Power Co-Springdale Station
Relation of Turbine Service Hours to Neutral Number of Lubricating Oil
No. 3 turbine-35,000 kw, 1800 RPM, 2000 gal system
Neutral Number
Curve "C"
Oil "C" is a medium priced oil of 1930-1935
Results
N N 0.80
10,138 service hours
269 gal makeup
Makeup added to system
1000 Turbine Service Hours

close to 1.0. At Springdale Station 0.80 was set as the limit, after which a batch of oil was discarded.

The neutral-number test is not of much value for testing the new oils that contain anti-oxidants. Some companies recommend that their oils should be discarded when the neutral number reaches 0.15. With a value as low as this the need of a test to substitute for the neutral number is evident. If 0.15 is the top limit above which it is unsafe to keep an oil in service, then it is necessary to have some other yardstick by which to judge an oil—possibly some method that will determine the amount of anti-oxidant remaining in the oil.

Interfacial-Tension Test

Wilson, Von Fuchs and Edlund[3] describe the interfacial tension test as "the only practical means of determining early stages of oxidation." This may be true, but sufficient data from actual service records have not been published to substantiate such a statement. If oxidation is inhibited by the presence of the anti-oxidant, what changes could be effected that would be indicated by interfacial tension? A recent check from five laboratories showing the interfacial tension on duplicate samples of five oils gave wide discrepancies. The interfacial-tension test may be the answer we are seeking; but before it can be accepted, substantiating data from both operation and laboratories must be correlated and proven. A few years ago the *hydrophil number* was hailed as the final answer for measuring amount of oxidation in an oil. Today there is little mention of this test.

The advent of anti-oxidants presented another picture; oil life in active service has increased from one or two years to an indefinite number of years. Life tests that had been used to judge an oil and in which a 40-hour life was considered excellent now extend into hundreds and sometimes thousands of hours before the oil has deteriorated to any extent. New means to predict the life of an oil are needed. Several committees are working on this problem and a test or tests will be devised. Tests applicable to the usual control laboratory cannot combine all the conditions that are encountered in actual service. No matter how carefully a laboratory test is controlled, the skeptic can always say that some feature was not considered.

Since corrosion in oiling systems has become a serious problem, satisfactory tests that will determine the corrosion-inhibiting qualities of an oil are essential. A simple and practical test that will predict the corrosion-inhibiting qualities of an oil has been developed at Springdale Station: 200 ml of the oil to be tested are placed in a 400-ml Pyrex beaker and agitated with a laboratory stirrer rotating at a high speed. One ml of distilled water is added and agitation continued for five minutes. The stirrer is removed as soon as possible, and the test strip is immediately placed in the emulsion.

The test strip is made of $\frac{3}{8}$-in. bar stock cold-rolled SAE 1112 steel freshly polished with a piece of crocus cloth and not touched by bare hands. The strip is about 90 mm long, so that when on test one end extends above the liquid level. A cover glass is placed on the beaker, which is allowed to stand at room temperature. The corrosion products, when magnetic iron oxide (Fe_3O_4), appear within 4 to 16 hours. The products formed after 16 hours are mostly ferric oxide (Fe_2O_3). If the test strip does not corrode within 48 hours, it will not corrode upon longer standing, and the oil can be considered to inhibit corrosion in the presence of water.

Operating Experience

Actual histories of oil in service best illustrate the developments that have been discussed. Here are results obtained since 1925 on a 35,000-kw, 1800-rpm unit with a 2,000-gal oil system equipped with a continuous bypass that removes oil from the reservoir and passes it through a conventional-type bag filter. In the following a service hour denotes a unit has operated one hour and does not mean elapsed time.

Oil *A* was one of the best oils that could be purchased prior to 1930; Fig. 1 (page 64) shows the neutral number plotted against service hours with this oil in service. As the neutral number increases, the curve rises at an accelerated rate, and the addition of make-up does not alter the slope of the curve. When using this oil, it was necessary to remove oil coolers at approximately 5000-hr periods to remove the accumulated

TABLE I—SERVICE LIFE TESTS ON LIGHT TURBINE OIL IN A 2000-KW UNIT

Oil brand	*E*		*F*		*G*	
Run No.	*E*1	*E*2	*F*1	*F*2	*G*1	*G*2
Service hours	888	576	814	470	1762	1384
% of elapsed time	50	10	40	15	50	50
Gallons make-up required	17	15	5	5	23	10
Neutral number when removed	1.79	0.92	0.50	0.46	0.18	17.40
Sludge	Heavy	Heavy	Medium	Medium	Slight	Medium
Reason for removal	Bearing failure	Oil condition	Bearing* failure	Condition* of oil	Recommendation of oil refiner	Condition of oil

* *Gelatinous coating on strainer and in oil lines*

sludge and varnish-like deposit that adhered to the tubes. At 17,490 service hours, the oil had a neutral number of 0.97, after having had 847½ gal of make-up added. Though dark in color, it was free of any sludge or suspended material until a leak in the cooler admitted water.

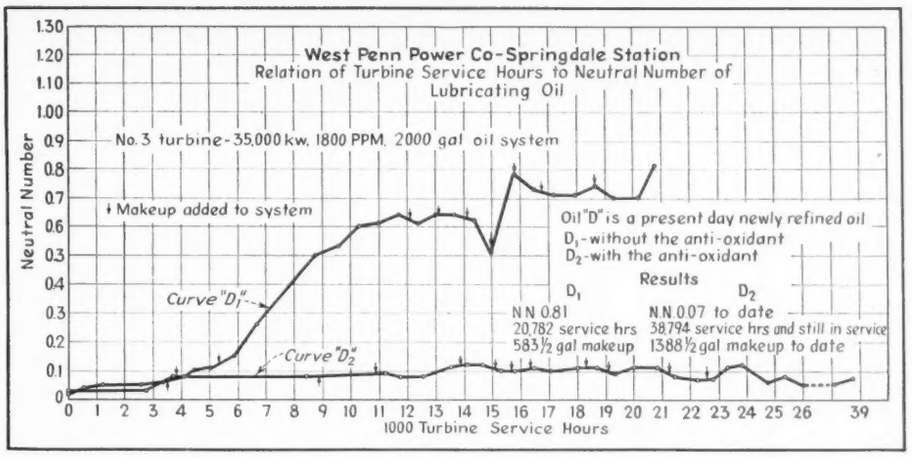
Immediately the operator noted a change in color of the oil and a sample was analyzed. It was found to have about 1% by volume of free water and very heavy sludge. The unit was taken out of service, and the oil replaced. Over four drums of sludge of a semi-gelatinous nature were removed, and all accessible lines were dismantled to permit a thorough cleaning of the system.

Batching of oil was next tried, this unit being one of three that was rotating four batches of oil. A study of the costs of this practice proved the method was not economical and after three years it was discontinued.

A Modern Oil

The next oil placed in the unit, oil *B*, was one of the first on the market refined by the new methods. The curve on page 65 shows results obtained with two batches of this oil. Curve B_1 shows the first batch that had 2840 service hours before a break occurred. At 3410 hours the neutral number was 0.12, and at 4723 hours the neutral number was 0.87. Curve B_2 shows the second batch, which was refined from a different crude than the oil shown on B_1. This oil had a neutral number of 0.10 at 1000 hours and 1.22 at 1339 hours. The thought advanced at this time, and later proven correct, was that the extra degree of treatment had removed some desirable constituent from the oil, thus making it more susceptible to oxidation and accelerated the rate of increase in neutral number.

Oil *C*, a medium-priced oil obtainable from 1930 to 1935, was next placed in the unit. Fig. 3 (left) is based on one batch that had a service life of 10,138 hours, required 269 gal of make-up during this period, and was replaced when the neutral number was 0.80. The service lives of three batches of this oil were identical and the time to replace a batch could be predicted with accuracy. At 6000 service hours a soft sludge that had to be removed had collected on the coolers and at 10,000 service hours the oil had to be replaced.


West Penn Power Co-Springdale Station
Relation of Turbine Service Hours to Neutral Number of Lubricating Oil
No. 3 turbine-35,000 kw, 1800 PPM, 2000 gal oil system
Neutral Number
Makeup added to system
Oil "D" is a present day newly refined oil
D1-without the anti-oxidant
D2-with the anti-oxidant
Results
D1
N.N. 0.81
20,782 service hrs
583½ gal makeup
D2
N.N. 0.07 to date
38,794 service hrs and still in service
1388½ gal makeup to date
Curve "D1"
Curve "D2"
1000 Turbine Service Hours

Oil D_1, a present-day highly refined oil, is illustrated above. It is interesting in that it shows the life of two batches of oil, one with and one without the anti-oxidant. Curve D_1—the oil without the anti-oxidant—shows the usual neutral number rise up to 12,000 service hours. At this time the oil was sweetened; that is, some oil was removed and make-up added in an endeavor to lower or at least stabilize the neutral number. During the next 4000 hours 20% of the oil was removed and new oil placed in the system without obtaining any great benefit. At 20,782 service hours, after 583½ gal of make-up were added, the oil was removed with a neutral number of 0.81.

Curve D_2 is the same oil with anti-oxidant added. At approximately 16,000 service hours considerable make-up was added, as 250 gallons of this oil was used (as the "old" oil) to inoculate a batch of new oil in another unit experiencing corrosion. This corrosion is discussed later. Oil D_2 now has 38,794 service hours, with a total of 1,388½ gal make-up, and a neutral number of 0.07. One noticeable feature is that for the last 18,000 hours of service it has not been necessary to clean the coolers on the oil side, which in itself aids in prolonging the life of the oil. The rate of metal poisoning decreases as the time elapses between the cleaning of the coolers. In service, oil will form a film on metal surfaces which makes the metal passive to poisoning the oil. The type of film formed by this oil has not interfered with heat transfer.

The ever-increasing number of new oils being offered and the many anti-oxidants developed made it desirous that some of these oils be tested. Lacking a satisfactory laboratory life test, service life tests were made by placing various oils in a small 2000-kw, 3600-rpm unit. The design of the bearings and lubrication system of the unit requires that a light turbine oil of approximately 150 viscosity at 100 F be used. This system holds 25 gallons and does not have coolers. In service, reservoir temperatures vary between 180 and 200 F. When not in service, the unit is kept hot so it is available for instantaneous use. As a result the oil in the system rarely drops below 130 F.

The exciter is built on the end of the generator shaft, and the oil line supplying the outboard bearing of the exciter is usually the first source of trouble. An oil high in viscosity or one that contains sludge or solids can readily cause the outboard bearing to fail. It has been our experience that, due to the elevated temperature at which the oil is always maintained, it will oxidize whether or not the unit is in service.

Test Results

Table I gives a summary of the histories of three brands of oils tested in this unit indicative of the results obtained with numerous oils. Brand *E* is a high-quality oil that does not contain an anti-oxidant. Brands *F* and *G* contain anti-oxidants, but are reported to be of different types and the results are in accord with this report.

Oil *E* on Run 1 had 888 service hours when the bearing failed. The neutral number was 1.79, and the oil contained large amounts of sludge. 17 gal of make-up were added to the 25-gal original charge during this period, and the unit was in service approximately 50% of the elapsed time.

Oil *E* on Run 2 at 576 service hours had a neutral number of 0.92, contained heavy sludge, and was removed as a precautionary measure. 15 gal of make-up had been added. The unit was in service approximately 10% of the elapsed time.

The first batch of oil *F* had 814 serv-

(*Continued on page* 136)

[1] "Oxidation of Petroleum Lubricants," L L Davis, B H Lincoln, G D Byrket, and W A Jones. *Industrial and Engineering Chemistry*, March, 1941.

[2] "Lubricating Oil Addition Agents," O M Reiff. *Industrial and Engineering Chemistry*, March, 1941

[3] "Evaluating Corrosion Resistance of Modern Turbine Oils," N B Wilson, G H Von Fuchs, K R Edlund. *Power*, March, 1941

[4] "Lubrication of General Electric Steam Turbines," C Dantsizen. Presented at ASME Meeting, December, 1940

High-Pressure Boiler-Feed Pumps—II

Feed pumps are large power consumers but they return practically all the energy input to the system as pressure or heat. Bypass arrangement is important for safe operation due to temperature rise at minimum flow

By IGOR J KARASSIK
Application Engineer,
Worthington Pump & Machinery Corp

▶ ONE GENERALLY THINKS of a centrifugal pump as a device for raising a quantity of fluid from a low pressure to a higher one, the sole effective output being measured in terms of quantity and pressure. Boiler-feed pumps, however, form part of a complex system in which heat quantities are even more important. Thus any increase in the heat content of the feedwater on its passage through the boiler-feed pump must be considered as useful work.

The difference between the brake-horsepower consumed and the water-horsepower developed represents power loss within the pump itself, all of which is transformed into heat. While theoretically it would be necessary to deduct from these losses both the bearing friction and the loss of heat through radiation, for practical purposes it is accurate enough to assume that all the heat is made available and removable in the feedwater passing through the boiler-feed pump.

The actual amount of temperature rise at any given operating condition can therefore be easily determined by multiplying the horsepower loss by 2545 (Btu equivalent of 1 hp) and dividing the total heat imparted to the feedwater by the corresponding flow in pounds per hour. Fig. 2 offers a graphical representation of this formula.

A Typical Example

In order to illustrate in a concrete form the physical phenomena which occur in the operation of the feed pump at various loads, a typical example is presented in Fig. 1. Obviously, the losses at low deliveries are greater, and as the total flow which absorbs the available heat is low, the temperature rise increases very rapidly with a decrease in flow. At full capacity of 625,000 lb per hr the temperature rise is only 2 F; it increases to 35 F at a reduced flow of 50,000 lb per hr.

The effect of temperature rise in a boiler-feed pump is beneficial from the standpoint of heat recovery, but can result in definite trouble in operation at light flows. The resulting excessive temperature rise will ultimately decrease the pressure margin over flashing in the first-stage impeller and lead to cavitation and vapor binding. In the event the pump incorporates a balancing device, similar flashing may occur therein, rendering the device inoperative. Finally, mechanical difficulties resulting from excessive expansion and ultimate seizing would seriously shorten the life of a pump, even if the periods of operation at abnormally low flows were brief.

Inasmuch as the capacity of a boiler-feed pump is solely governed by the main-turbine load, the only specific means of insuring a definite minimum flow is the installation of a bypass on the discharge side of the pump. This bypass should be located ahead of the discharge gate or check valve and return to some region of lower pressure in the boiler-feed cycle.

The minimum flow that can be safely handled in a feed pump is, of course, determined by the maximum allowable temperature rise. While no exact limit can be set to cover all cases, some value between 15 and 20 F represents usual practice. Since the relation between shut-off brake hp and the heat losses at low flows holds quite accurately for practically all centrifugal boiler-feed pumps, it is possible to establish a simple rule of thumb regarding minimum flows. To hold within a 20-F limit

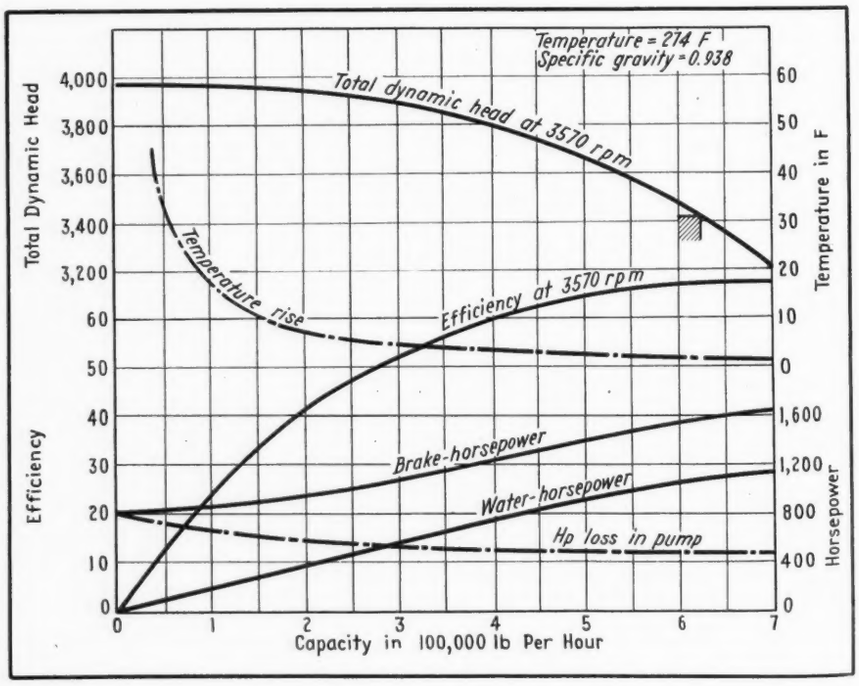


Fig. 1—Performance characteristics of typical 6-in, 6-stage boiler-fed pump showing amount of temperature rise from heat loss

Editor's Note: Second part of a condensed excerpt from Mr Karassik's paper which was awarded first prize by the Hydraulic Institute. The first article appeared in March, POWER, *page 63.*

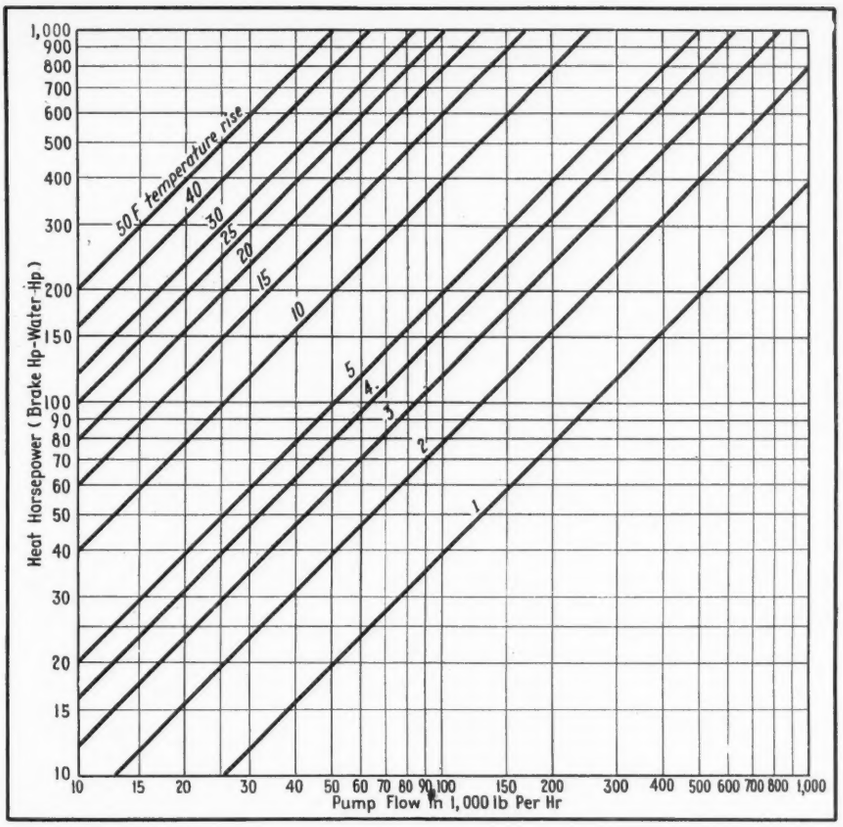


Fig. 2—Temperature rise within boiler-feed pump increases rapidly at low flows as can be calculated from this chart of heat horsepower

of temperature rise requires a minimum flow of 11,000 lb per hr for each 100 bhp at shut-off, while if a 15 F limit is to be held, the minimum flow becomes 15,000 lb per hr per 100 bhp. Thus, for instance, for a 20 F rise in the pump illustrated in Fig. 2, the minimum flow would be 90,000 lb per hr.

This minimum flow may, of course, include the leak-off from a balancing disk or drum, if such a device is employed to balance end thrust and if the balancing device leak-off is returned to the heater. The balancing leak-off depends on the design of the disk or drum and on the pump operating speed, ranging from a minimum of 10,000 lb per hr to a top of perhaps 40,000 lb per hr.

The decrease of pressure energy in the balancing device is, of course, accompanied by a temperature rise. Thus, if the pump of Fig. 2 were assumed to be fitted with a balancing disk that allows a 15,000-lb-per-hr flow, the temperature rise in the disk proper would be 5 F in addition to the rise that takes place in the pump itself. Of course, the latter would have to be recalculated to allow for the difference between the real and apparent flows through the pump, since the capacities plotted on Fig. 2 were discharge and not suction capacities. At high flows the discrepancy is negligible, but at lower flows the difference increases. Fig. 3 shows the actual temperature rise at the discharge from the pump of Fig. 2, as well as the temperature rise at the exit from the balancing disk.

The problem, from the operator's viewpoint, becomes one of disposing of the leak-off and the bypass as well, taking into consideration full knowledge of the amounts of flow involved and of their respective temperatures. The simplest piping arrangement would result from returning the balancing device leak-off to the pump suction. However this involves raising the suction temperature, as the leak-off would be allowed to mix with the incoming feedwater, in many instances, the net suction head above flashing is not too great and even a few degrees rise is not permissible. For the pump of Fig. 2, the mixture would increase by about 3 F at 100,000 lb per hr, increasing still further with a decrease of the total discharge flow.

Suction Conditions

If the pump takes its suction from the discharge of a primary pump, the margin between suction pressure and vapor pressure is relatively great and the leak-off may be piped to the pump suction with safety. If, however, the suction comes from a direct-contact heater, the margin may be insufficient and the leak-off might better be returned to the direct-contact heater where the excess heat can flash to steam without affecting pump operation.

Disposal of the bypass protecting the pump at low flows can be considered either as a separate problem or in combination with the leak-off. Obviously, in order to avoid a cumulative effect of the

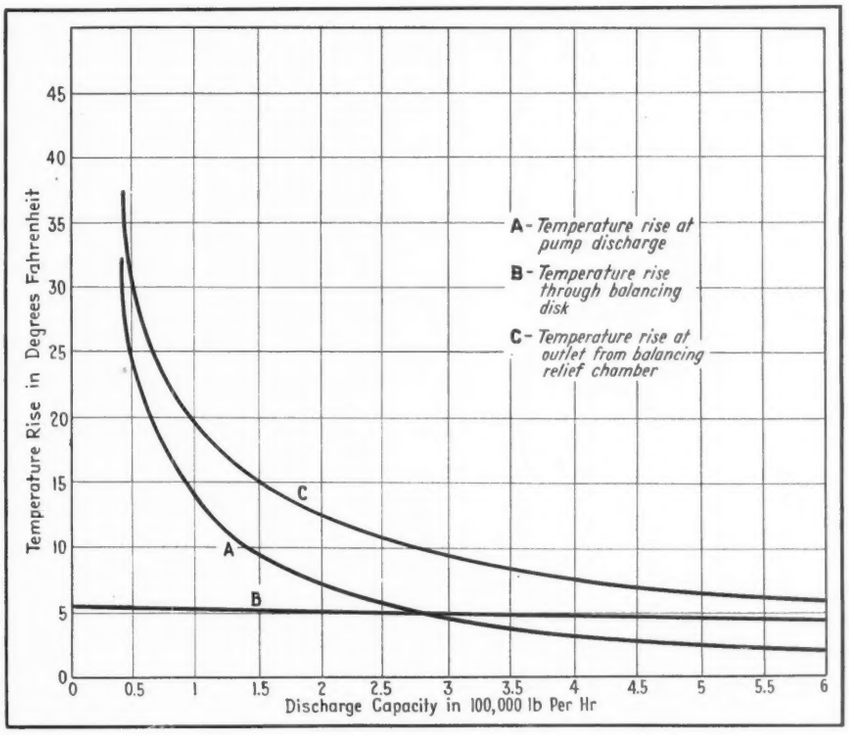

Temperature Rise in Degrees Fahrenheit
Discharge Capacity in 100,000 lb Per Hr
A - Temperature rise at pump discharge
B - Temperature rise through balancing disk
C - Temperature rise at outlet from balancing relief chamber

Fig. 3—Water temperature rise in pump proper and in balancing device can result in high temperature at outlet of balancing relief chamber

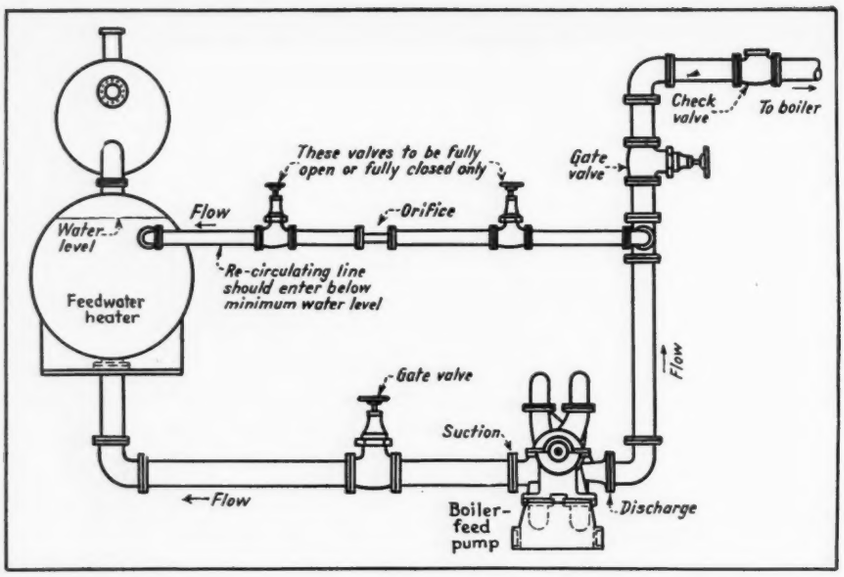


Fig. 4—Bypass arrangement for manual control offers protection against excessive temperature rise at low flows. Orifice is calculated to pass required minimum.

temperature rise it is necessary to return the bypass to the direct-contact heater, so as to allow the recirculated feedwater to mix with all the feedwater in the storage space and dissipate the heat that it contains. Such an arrangement is shown in Fig. 4, with an orifice to limit flow, and valves for manual operation. The bypass takes off from the discharge line ahead of any valves and returns to the heater below water level.

The orifice is calculated to pass a predetermined minimum safe flow through the pump to limit the temperature rise. Of course, it must break down the full pressure generated by the pump, and, for pressures over 300 lb, it may be necessary to employ a series of several orifices. This arrangement not only reduces the wear incidental to breaking down a high pressure but also eliminates the noise produced by a single-step breakdown at high velocities.

Bypass-Flow Control

Control of the flow through the bypass can be automatic, manual, or the flow can be continuous. Automatic control of the bypass valve has found favor with a number of operators, because it reduces the hazard of running the pump below its proper minimum flow with accidental failure to open the bypass valves. The actuating mechanism may be governed by (1) the position of the feedwater regulator (2) the pressure at the pump discharge or (3) flowmeter control in the pump suction or discharge.

The first is impractical if two or more pumps are operated in parallel. The second is somewhat complicated by the flatness of the head-capacity curve of a high-head centrifugal pump; the difference in pressure at low flows is not sufficient to insure positive and sensitive control. Flowmeter control, usually located on the suction side of the pump in order to measure the actual amount of feedwater passing through the pump, offers the greatest reliability.

Flowmeter control can be quite simple. A nozzle or orifice provides the necessary pressure drop for a standard flowmeter equipped with a contactor to open a solenoid-operated bypass valve when flow falls below a predetermined minimum. To avoid hunting, the valve is closed on flow somewhat greater than the sum of the minimum and of the bypass flow. As a precaution against current failure, the bypass valve is held closed by an energized solenoid.

Balancing Costs

However, inasmuch as automatic devices increase installation costs appreciably, it is advisable to reach a reasonable compromise between the most efficient and the most practical disposal of the recirculated bypass. Inasmuch as the degradation of pressure energy in the bypass orifice is accompanied by a gain in thermal energy, it is incorrect to consider the recirculation of feedwater as an entire waste. Further, since the increase in brake-horsepower does not vary directly with an increase in flow, a continuous bypass of 10% of the full-load capacity corresponds to only about 3% increase in real power expenditure. This increase is but a small premium to pay for insurance against pump failure through operation at abnormally low flows, and serious consideration should be given to manual control of the bypass, open *at all flows.* It will become necessary to close the bypass only when the full-load capacity of the pump, less the bypass capacity, no longer suffices to fulfill the boiler demand.

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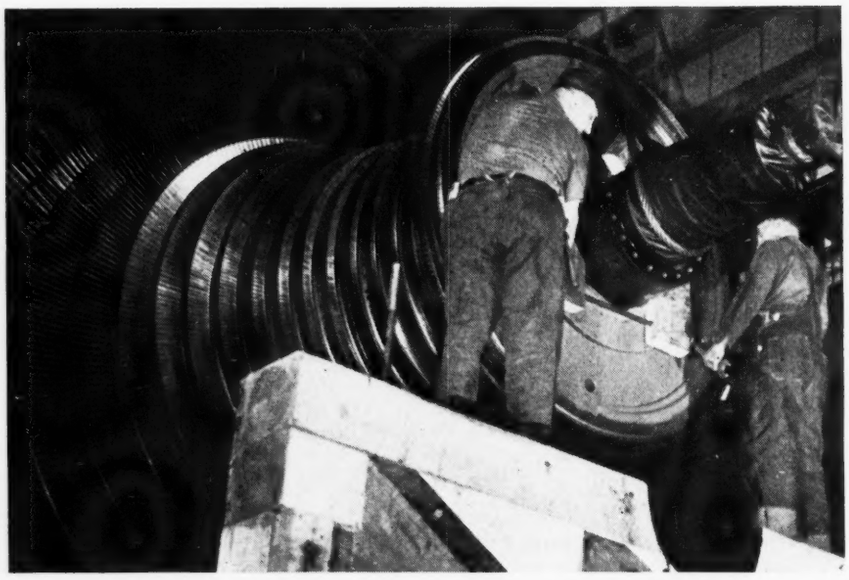
NO. 2 FOR OSWEGO GOING IN



This huge turbine-generator will soon be spinning out 80,000 kw at Central New York Power Co's new $16,500,000 Oswego Station. It is shown here being cradled for shipment recently in the Schenectady Works of the General Electric Co. The first unit went into service last summer

THE OLD CHIEF

VII – Good Housekeeping

Seventh in a series by William Doran, chief engineer, Essex County Sanatorium, Windsor, Ontario. Writing of the inspiration of the past, he has captured much of the human side of engineering that lies beneath the maze of power-plant costs and the wavy lines on paper disks

The Old Chief was laid up with a bad attack of lumbago

▶I REMEMBER ONE WINTER the Old Chief was laid up with a bad attack of lumbago. When I called on him I discovered that, like most normally healthy men, he was a very bad patient. He fussed and fumed at his inactivity and tried hard to draw from me some reason why he "just had" to go down to the plant that very day. I assured him that everything was running fine and soon had him conversing quietly in his own inimitable way.

He spoke of power plants he had visited both here and abroad, and advised me always to fish for opportunities to visit the other fellow's plant. "Remember", he said, "the kibitzer sees more than the players do." He went on to tell me that he had visited in his day almost as many power plants as he had peoples' homes—all the way from Ford's big Rouge plant in Detroit to dinky little one-lung heating plants. And as for the homes he had visited, they ranged from the dwellings of duke's sons to cook's sons, and there was, he assured me, much in common between the way people keep their homes and the way engineers keep their power plants.

Some homes give the impression of well-ordered routine, good housekeeping ability and that wholesome efficiency that makes a very useful dwelling place. There are many power plants like that and they reflect the personality of those in charge just as clearly as does the home of the successful homemaker.

The Old Chief went on to tell me that he had visited plants that reminded him very much of a bachelor's shack he once saw. You could smell it before you could see it—the two dark rooms contained dust, grime and vermin. It was useless as a dwelling place and endurable only to those accustomed to such surroundings.

"And", he added, "I could take you to plants like that in every city in the country, where the 'bums' of the factory do their heavy loafing, where windows are never cleaned and the floor is littered with all the debris anyone cares to dump there, where a motor has to burn out in order to be cleaned, and where the management is obliviously happy just as long as it has low-paid men to poke coal in a hole."

He then told me about an evening his good wife had taken him to visit the dainty apartment of a maiden lady of decided artistic tastes. There were period chairs finished in needlepoint with straight backs and darned uncomfortable to sit on. The kitchen was a picture of porcelain, but the lady never fried anything in it because it might mess up the stove. The apartment was just about as useful for a home as the window of an electrical appliance shop.

This in turn reminded him of a dairy plant he knew where they purchased metal polish by the barrel and lubricating oil by the pint—where efficiency ran second to show. "Perhaps it is my bad taste," he said, "but I prefer usefulness to showing off."

No Replacements

Another type of home he described was the one where the poor housewife tries hard to make good with outmoded and broken-down furniture, worn-out and discolored linen and dishes. One has to be very careful in visiting a home of this kind because the springs have gone in the Chesterfield, the chairs are patched up and dangerous to trust one's weight to. The cook stove takes twice as long to bake a cake, and uses twice as much fuel, as a modern one would, but the lord and master prides himself that he can always talk the poor woman down when she asks for any "fal-de-rals".

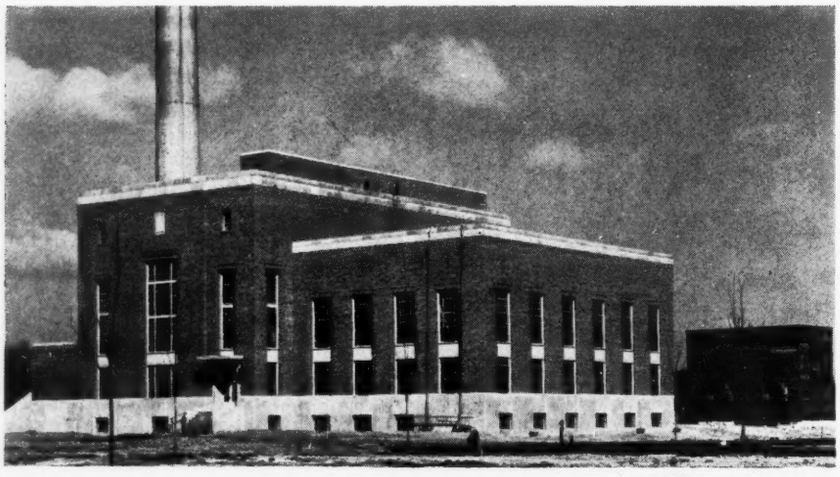
"How many engineers," he questioned, "are talked down when they ask for just a little modernization in their plants?" There are many such plants, where depreciation and procrastination go hand in hand with danger and wilfull waste. He had heard politicians waxing eloquent on the subject of slum-clearance projects in the interest of national health, and he regretted that we could not wipe out slum plants in the interests of national production and conservation of national resources.

Seeing that he was worked up on the subject, I asked him if it would not be a good idea to emulate the Tuberculosis Association and sell seals to stamp out carbon monoxide in underprivileged power plants. In reply, he told me to go home, as I was only making his lumbago worse.

Reasons Behind the New University of

There's a powerful lot of thinking, investigation and engineering analysis preceeding the actual doing. Here is detailed account of why and how Sargent & Lundy went about bringing this university plant up to date in a new building

By GUSTAF A GAFFERT
and
FRANK V SMITH
Sargent & Lundy, Chicago



Major improvements to steam and electrical-generation facilities at the University of Illinois were made necessary by additions to library and hospital, a new student center, replacement of an inadequate classroom building, a new laboratory building, a dormitory or two and an experimental fuel laboratory. The existing 150-lb plant, extended several times since original construction in 1909, continued eight longitudinal-drum, stoker-fired boilers. Electrical plant consisted of one 1000-kw and two 500-kw non-condensing units, generating at 2300-volt distribution potential, and exhausting to the heating system. The exterior of the new plant is shown above.

Electric loads of over 2500 kw had already taxed the power supply and provision for additional power and emergencies was being furnished by the neighboring public utility. Sargent & Lundy were retained to advise whether the existing plant should be rebuilt or a new power plant constructed, based on an analysis of the added campus building.

The reasons for a new plant instead of possible modernization are apparent from the following analysis: A better standard of illumination was desirable, in keeping with modern trends. The new buildings were planned accordingly. Air conditioning was scheduled for the new classroom building and student center. Electrical requirements of these new buildings (including normal growth of electricity in the remainder of the campus buildings of some 2 per cent per year) indicated a peak load in the vicinity of 3400 kw in 1940–41. Similar studies of heating-system requirements indicated that the peak demand with minus 10 F outside temperature would increase from 145,000 lb per hr to 200,000 lb per hr in a 10-year period.

All of these studies were based upon the present building program and building work contemplated. Consideration was also given to the effect on probable peak loads of increasing the illumination standard for existing buildings. These large increases in electrical load could not be carried on the existing distribution system and it was therefore proposed to change to a 4160-volt, 3-phase, 4-wire system and to divide the campus into a number of load areas, each fed by a circuit from the power station with emergency reserve feeder looping through the several areas.

Rehabilitation of the existing power plant was next considered. This plant

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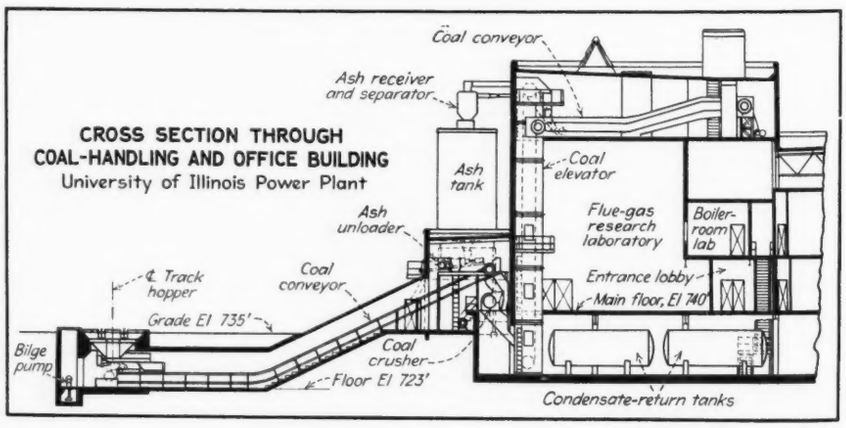
The coal-handling system (Jeffrey) is designed to handle 75 tons per hr. Coal falls from side- or bottom-dump cars into a track hopper. A reciprocating feeder supplies an apron conveyor. If necessary the coal is crushed, then sent to the boot of a bucket elevator. Two horizontal scraper conveyors operating in enclosed housings bring the coal to the bunkers. Cinder, ash, and soot are collected from the ash pit, stoker wind-boxes, siftings hoppers, last pass of boiler, dust-collector hoppers, and stack base by a United Conveyor steam-exhauster system.



Illinois Plant

is located at the northern extremity of a campus approximately two miles long and one mile wide. All projected growth was toward south and west so that additional steam distribution mains would be necessary. The existing switchboard was of the open type and circuit breakers of increased rupturing capacity would require a new board.

Space was available in the old boiler room by removing six of the existing boilers, which had no heat-recovery equipment, for the required three new 80,000-lb-per-hr steam generators. Also by making certain rearrangements in the turbine room, it would have been possible to install two turbines of 3000 kw capacity each. In such an event the steam pressure would have to be raised to 300 or 400 lb and the temperature as high as permissible to produce not over 400-F exhaust conditions. Temperature- and pressure-reducing equipment would be necessary to connect the new boilers with existing generating equipment. A considerable amount of alteration work would have to be done to the structural-steel supporting structure, and building walls and floors altered. Further, the program would have to be done in steps to keep the existing plant operating.

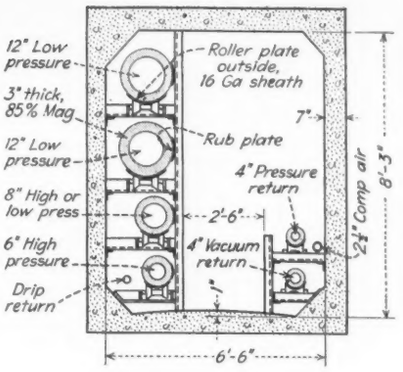
The program eventually followed was to build a new power plant located strategically with respect to fuel supply directly adjacent to the main line of a railroad on the west side of the campus and near the future expansion area. A fairly long steam-distribution supply main, preferably in a tunnel, would be necessary to connect with the existing system. Electric cables from the power plant to the load centers also would be somewhat longer. On the other hand coal-storage facilities would be adjacent to the plant and ample space available for future expansion.

In establishing the proper location for the new plant, the following factors were given considerable weight:

1. The projected future growth of the campus indicated that the center of gravity of electric and steam load was moving southward. Practically all buildings projected and under construction were in the south area.

2. Coal facilities available (including storage) at the site of the new plant were superior to those at the existing station. In the latter case, the track to the station ran through the main street of the City of Urbana and there was some possibility that this track might later have to be removed.

3. Maintaining continuous service was necessary even during construction and cutting over present to projected facilities. A new plant could, of course, be constructed entirely separate from the existing plant operation, and each cut-over planned independently of operation.



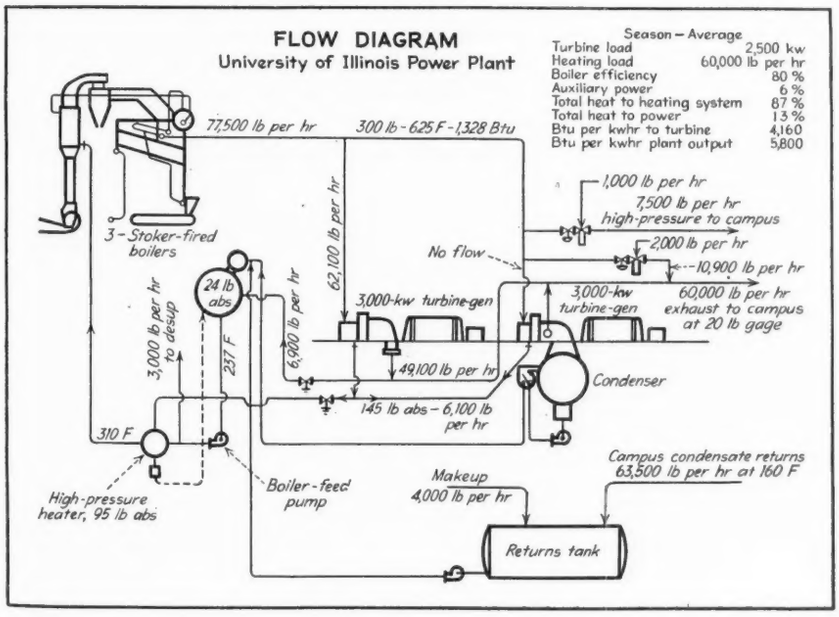
The steam-distribution tunnel houses two 12-in. low-pressure, one 8-in. high or low-pressure, one 6-in. low pressure, two 4-in. condensate return and one 2½-in. compressed air lines and is 6⅞ ft x 8 ft 3 in. in cross section. Maximum steam pressure expected is 70 lb at 200,000 lb per hr flow. Steam lines are welded throughout.

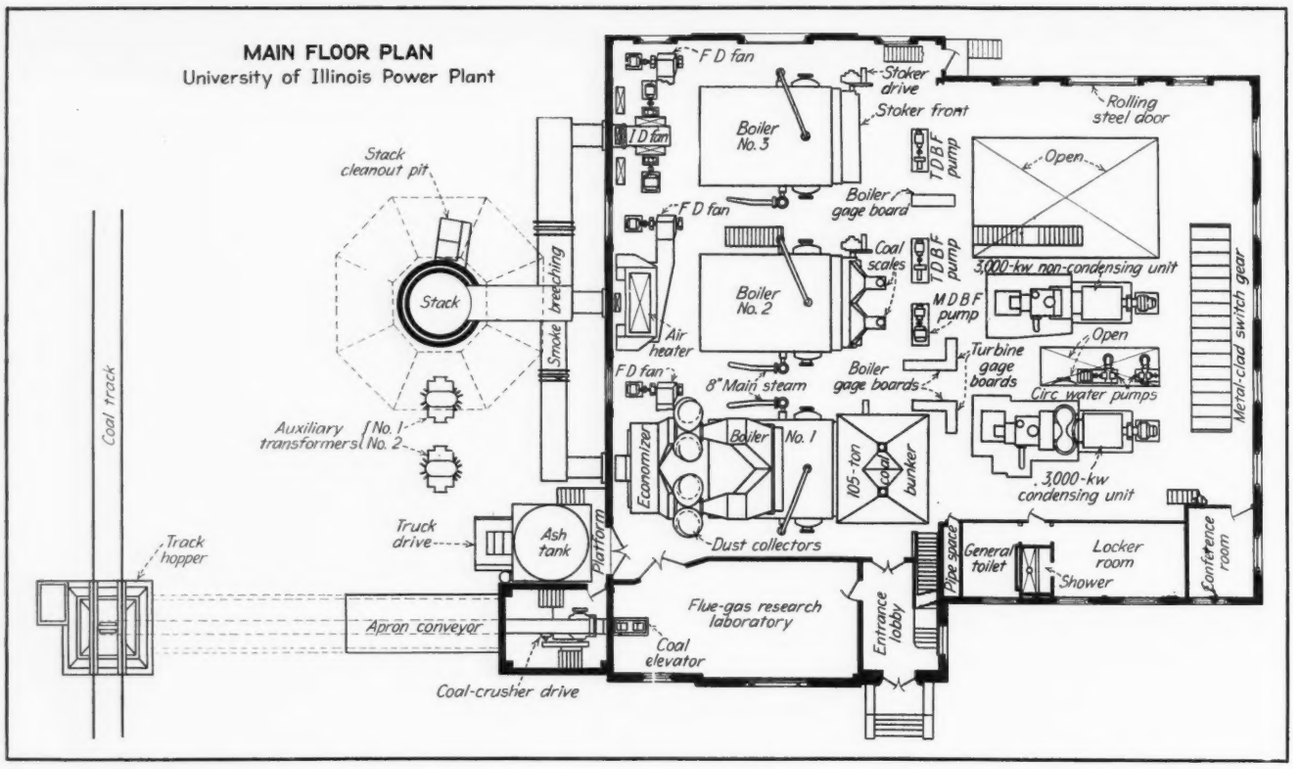
Expansion amounts to 110 in. in the 4000-ft run and is taken care of by double-offset expansion loops on approximately 750-ft centers. No loops are used at corners; the pipes are allowed to slide on flat-plate supports. Provision is made for drainage and storm-water removal at the expansion-loop vaults. Electrical-distribution cables run in tile conduit about 6 ft from the pipe tunnel with manholes at suitable distances.

The heat charged to power is nominal, as the diagram above shows, since power is produced largely in reducing steam pressure to heating-system requrements. A high initial pressure is economically inadvisable. A throttle temperature of 625 F results in maximum exhaust temperature to the heating system of 350 F. Both an automatic extraction condensing and a backpressure turbine are utilized to allow flexibility in operation.

Two 3000-kw General Electric turbines supply power. The condensing unit supplies heating steam through a grid valve at pressures up to 70 lb with exhaust to a 2500-sq-ft Allis-Chalmers surface condenser. In the summer months this unit will operate condensing with two-point extraction for feedwater heating. Since no cooling water facilities are available, a Marley forced-draft tower (double-sheathed wall construction) cools 5700 gpm from 100 F to 90 F with a wet bulb of 78 F. The backpressure unit exhausts to the heating system at pressures up to 70 lb and has one uncontrolled extraction point for feedwater heating.

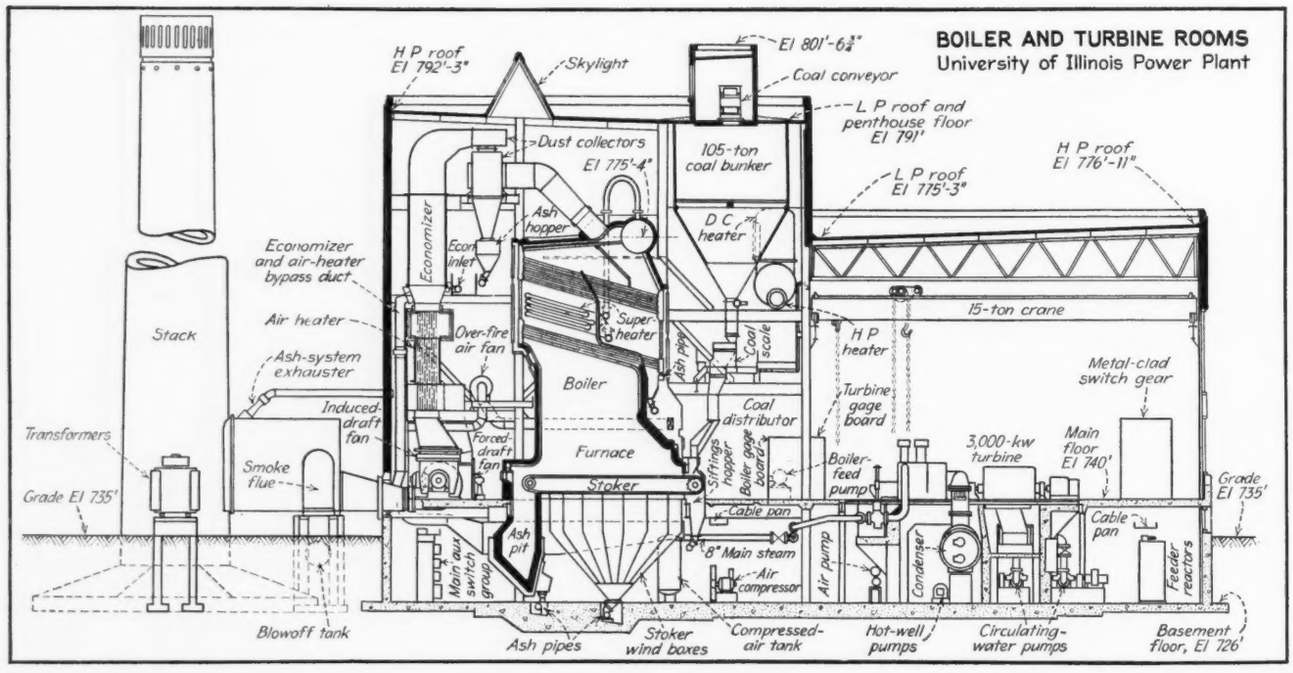
A pressure- and temperature-reducing station provides makeup steam when turbine exhaust is inadequate. All campus condensate returns are collected in a deaerating heater floating on the heating supply line and their temperature further raised to 300 F in a high-pressure heater before entering the economizers.


FLOW DIAGRAM
University of Illinois Power Plant
Season – Average
Turbine load 2,500 kw
Heating load 60,000 lb per hr
Boiler efficiency 80 %
Auxiliary power 6 %
Total heat to heating system 87 %
Total heat to power 13 %
Btu per kwhr to turbine 4,160
Btu per kwhr plant output 5,800
77,500 lb per hr
300 lb - 625 F - 1,328 Btu
3 - Stoker-fired boilers
62,100 lb per hr
1,000 lb per hr
7,500 lb per hr high-pressure to campus
2,000 lb per hr
10,900 lb per hr
No flow
24 lb abs
3,000 lb per hr to desup
237 F
6,900 lb per hr
3,000-kw turbine-gen
3,000-kw turbine-gen
60,000 lb per hr exhaust to campus at 20 lb gage
49,100 lb per hr
Condenser
145 lb abs – 6,100 lb per hr
310 F
Campus condensate returns 63,500 lb per hr at 160 F
High-pressure heater, 95 lb abs
Boiler-feed pump
Makeup 4,000 lb per hr
Returns tank



The plan view of the new plant shows the three Springfield cross-drum boilers of 80,000 lb per hr rated capacity each. Vermilion County, Ill., strip-mine coal is fired by Babcock-Wilcox chain-grate stokers. The completely water-cooled furnace has a heat release of 30,000 Btu per cu ft per hr at rated capacity.

A flue-gas research laboratoy is incorporated in the main building. This laboratory extends from the main floor to the coal conveyor floor with a shaft to atmosphere for venting apparatus installed in the laboratory. It is hoped to conduct research on a large scale on various types of projects closely associated with power-plant practice in this laboratory.

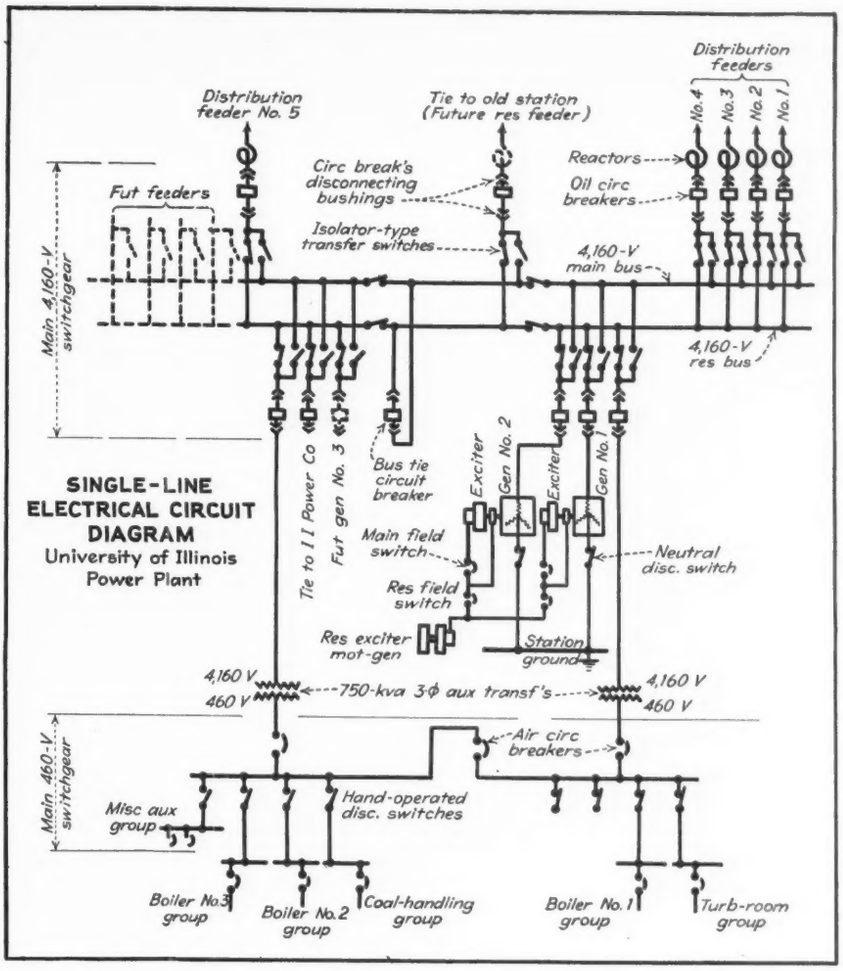


Selection of stoker firing instead of pulverized fuel seemed advisable because of proximity of the campus and prevailing winds, range of load, lower maintenance, and usability of stoker cinder for road grading. Buell type centrifugal collectors between the boiler and economizer, above, remove practically all of the cinder and flyash. Both economizers and air heaters are employed to reduce the final exit gas to 375 F at rated capacity. While present throttle temperature is 625 F, the design allows for an increase to 700 F if that proves advisable in the future.

The electrical-connection diagram shows the generators supplying a 4160-volt double bus using lift-up-type Allis-Chalmers metal-clad switchgear with circuit breakers of 150,000-kva rupturing capacity. From the station, 4-conductor, No. 00 underground cables feed the various load centers from which cables run to individual buildings.

Station auxiliaries operate at 440 volts and are supplied by two 750-kva transformers from the main bus, one transformer being a spare. Auxiliaries are fed from groups of air circuit breakers either manually or electrically operated as conditions require. The station has Leeds & Northrup frequency control and time-error correction.

Since completion of the project an electrical load of 3600 kw has been carried on the system. The 1000-kw turbine is being retained for the present for standby service and is supplied with steam through the 6-in. high-pressure steam line. The program of adding new load centers will be carried on as funds are available, and eventually all load will be fed from the new power plant. An adjacent substation is being constructed to allow interchange of power between the University and the Illinois-Iowa Power Company, a desirable feature to allow each system to take advantage of diversity of load and provide for emergencies.



Principal New Equipment

University of Illinois Power Plant—Champaign, Ill.

CONSULTING ENGINEERS—SARGENT & LUNDY

Steam-Generating Equipment:

Boilers, 3, cross-drum straight-tube.....Springfield Boiler Co
80,000 lb per hr each, 325 lb, 650 F, 6600 sq ft heating surface, 1850 sq ft water wall, 2180-sq-ft return-bend economizer, 4950-sq-ft tubular air pre-heater. Furnace volume 3450 cu ft
Stokers, 297 sq ft, traveling grate.....Babcock & Wilcox Co
Forced-draft fans, 3, 33,000 cfm, 8.75-in. sp.....B F Sturtevant Co
Double-width, double-inlet turbovane with vane control
Drive, 75-hp, 1750-rpm, sc motor.....Westinghouse Elec & Mfg. Co
Induced-draft fans, 3, 56,000 cfm at 400 F, 9-in. sp..B F Sturtevant Co
Double inlet-damper control
Drive, 150-hp, 1165-rpm, 75-hp, 878-rpm, sc motors .....Westinghouse Elec & Mfg Co
Overfire-air fans, 3, 4000-cfm at 275 F.....B F Sturtevant Co
Drive, 7.5-hp, 1750-rpm sc motor.....Westinghouse Elec. & Mfg Co
Dust collectors, 4 per boiler, single cone, cyclone....Buell Engrg Co
Located between boiler and economizer, storage cap. 15 tons, draft loss, 2.5 in. Collection efficiency 94% based on 30% dust through 325 mesh

Power-Generating Equipment:

Turbine No. 1, 3000-kw automatic-extraction condensing .....General Electric Co
3600 rpm, 300 lb, 625 F. Extraction up to 170,000 lb per hr, 70 lb pressure, one non-automatic bleed point. Generator 4160 volts, 0.8 pf. 25-kw, 125-volt exciter
Turbine No. 2, 3000-kw backpressure.....General Electric Co
3600 rpm, 300 lb, 625 F, variable exhaust pressure up to 70 lb, one non-automatic bleed point. Generator, 4160 volts, 0.8 pf. 25-kw, 125-volt exciter
Condenser, 2500 sq ft, 2-pass, arsenical copper tubes .....Allis-Chalmers Mfg Co

Pumping Equipment:

Hotwell pumps, 2, 90 gpm, 180-ft. head, 4-stage .....Allis-Chalmers Mfg Co
Drive, 15 hp sc motor, 1750 rpm.....Allis-Chalmers Mfg Co
Drive, 15-hp Zs steam turbine, 1750 rpm....Terry Steam Turbine Co
Circulators, 2, 2400 gpm, 52-ft head.....Allis-Chalmers Mfg Co
Drive, 40-hp sc motor, 1750 rpm.....Allis-Chalmers Mfg Co
Drive, 36-hp Zs steam turbine.....Terry Steam Turbine Co
Boiler-feed pumps, 3, 100,000 lb per hr Penna. Pump & Compressor Co
Developed head 430 lb at 3485 rpm, 4-stage
Drive, 100-hp sc motor.....Westinghouse Elec & Mfg Co
Drive, 2, 100-hp Zs steam turbines.....Terry Steam Turbine Co

Feedwater System:

Treatment, hydrogen zeolite equipment.....Permutit Co
2 Descalso softeners, 1 Zeo Karb H unit, degasifier and blower
Direct-contact heater, 200,000 lb per hr, 3500-gal storage .....Hoppes Mfg Co
Closed heater, 4-pass, 200,000 lb per hr.....Whitlock Coil & Pipe Co

Coal- and Ash-Handling Equipment:

Track hopper, apron feed, bucket elevator, scraper conveyors .....Jeffrey Mfg Co
75 tons per hr, ¾-in. crushed coal, remotored American Ring crusher, 1, 75-fpm Superduty-Gravity bucket elevator, 2, scraper conveyors, 50-fpm, 24-in. Motor drives with speed reducers. Reciprocating plate feeder driven from apron feeder.
Ash-removal system, storage silo, dustless unloader .....United Conveyor Corp
45 ton-per-hr capacity, 40 tons storage, removal from stoker ash hoppers, wind boxes, siftings hoppers, rear boiler pass, dust-collector hoppers and base of stack

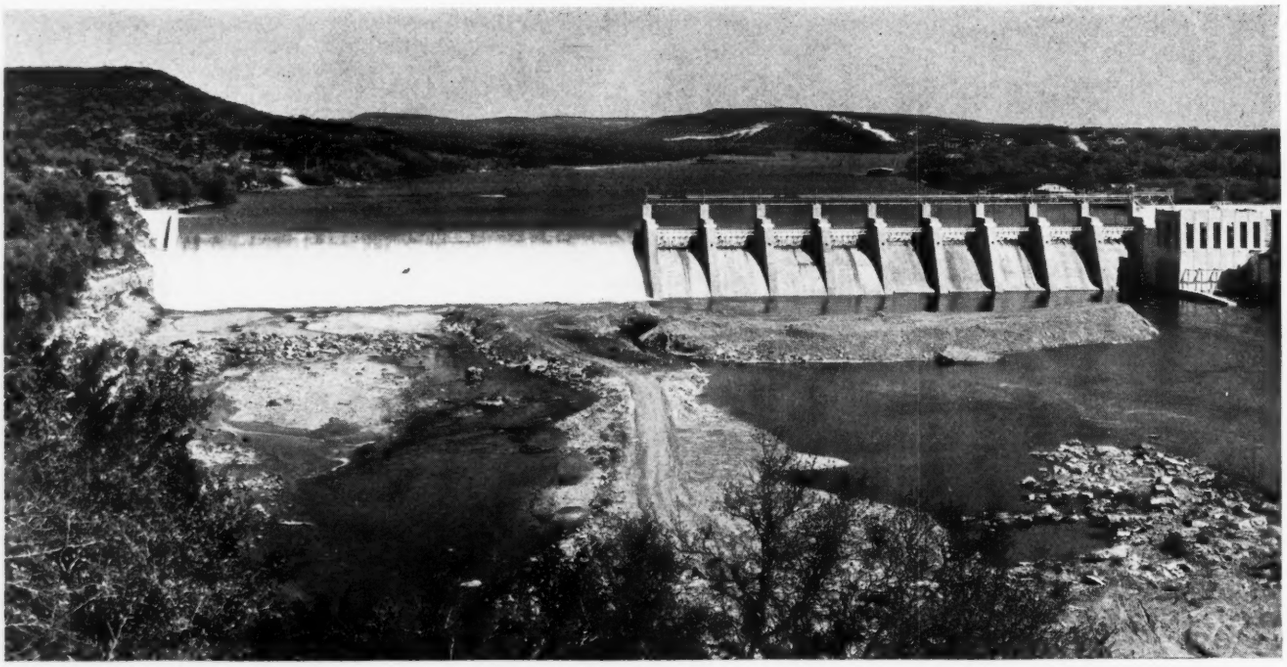
Electrical Equipment:

Main switchboard, double bus, metal clad.....Allis-Chalmers Mfg Co
Rated voltage, 7500; operating voltage, 4160; 3 phase, 4 wire, oil breakers
Auxiliary switchboard, 440 volts Marquette Electrical Switchboard Co
Air circuit breakers.....I-T-E Circuit Breaker Co
Auxiliary and lighting transformers....Pennsylvania Transformer Co
Storage battery, 30 amp, 8-hr rating.....Gould Storage Battery Co
Electrical contractor.....A S Schulman Electric Co

Miscellaneous Equipment:

Turbine-room crane, 15-t, hand-travel bridge and trolley.Whiting Corp
Cooling tower, 2-cell, forced-draft.....Marley Co
Chimney, 200 ft. 9-ft dia at top, 100-ft brick lining .....Heinie Chimney Co
Combustion control, Smoot, air-operated....Republic Flow Meters Co
Controls forced-draft-fan dampers and vanes, induced-draft fan-inlet dampers and stoker variable-speed drives
Gage boards, 2 turbine, 3 boiler panels....Republic Flow Meters Co
Steam flowmeters.....Republic Flow Meters Co
Boiler meters and draft gages.....Bailey Meter Co
Temperature recorders.....Leeds & Northrup Co
Pressure gages.....Consolidated-Ashcroft-Hancock Div
Thermometers.....Taylor Instrument Cos
Venturi meters.....Builders Iron Foundry
Oil filtering equipment, precipitation tank and pumps .....S F Bowser & Co
Substructure and superstructure..... W A O'Neil Construction Co
Flues and ducts.....Terre Haute Boiler Works
Misc steel and iron.....Edwin Pratt Sons
Insulation.....Asbestos & Magnesia Materials Co
Piping contractor .....Wm A Pope Co
Piping fabricator .....Crane Co
Non-return valves .....Edward Valve & Mfg Co
Main steam and feed valves.....Crane Co
Atmospheric and relief valves.....Atwood-Morrill Co
Feedwater regulators and desuperheaters (Copes) .....Northern Equipment Co
Boiler blowoff valves.....Okadee Co

Adjustable-Blade Turbines Attain 93%



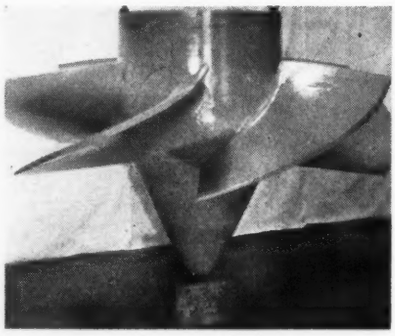
Looking up the Colorado River in Texas at the Austin Dam. 20,000-hp hydro plant is at extreme right

Automatic adjustable-blade turbines, the comparatively high head under which they operate, and the complete tests which these units have undergone, make the Austin Dam plant an outstanding example of modern hydroelectric efficiency. This installation is one of four plants built in Texas by the Lower Colorado River Authority for flood control and power generation.

In the two 10,000-hp Austin turbines, runner blades are pivoted so that they adjust themselves automatically to the most efficient angle for each gate opening and head, for constant-speed operation. Blade-opening mechanism is concentrated in the runner hub and is entirely separate from the governor-oil-pressure system. Angle of the blades is controlled by the quantity of water flowing through them.

The first installation of a Terry automatic-adjustable-blade hydraulic turbine, in the Marmet plant in West Virginia, was described in February, 1937, POWER. That unit has a runner 177 in. in diameter and develops 7600 hp at 90 rpm and 23 ft head. This initial turbine was followed by two others with same-size runners, but rated 9150 hp under 26 ft head. The latest steps in this development are the two Austin turbines, each developing 10,000 hp at 200 rpm under 61-ft head.

Additional information on the Austin units was presented by the writer in a paper "The Development of the Automatic Adjustable-Blade-Type Propeller Turbine," at the December, 1940 meeting of the ASME.



Runners have six cast-steel blades and are 102 in. in diameter, which narrows down to 100 in. at the throat in the top of the draft tube—the smallest diameter of the water passage. The photo shows the blades in an intermediate angular position.

Each blade is pivoted on two roller bearings on the hub; radial thrust due to centrifugal force is taken by a roller thrust bearing. Because of the cantilever nature of the blades and the large hydraulic thrust or load on them, amounting to about 160,000 lb at 63-ft head, these bearings are quite heavily loaded. At runaway speed of 400 rpm, each thrust bearing will carry a load of 122,000 lb, though at normal 200 rpm thrust amounts to only one-fourth that amount.

Bearings are 15- to 18-chromium stainless steel with bronze cages and have a rated capacity of 70% of a similar carbon-steel bearing, based upon a minimum Rockwell "C" hardness of 52. Hardness, however, averages 55 Rockwell "C," so that actual capacity of these bearings is about 90% of a carbon-steel bearing of the same physical dimensions.

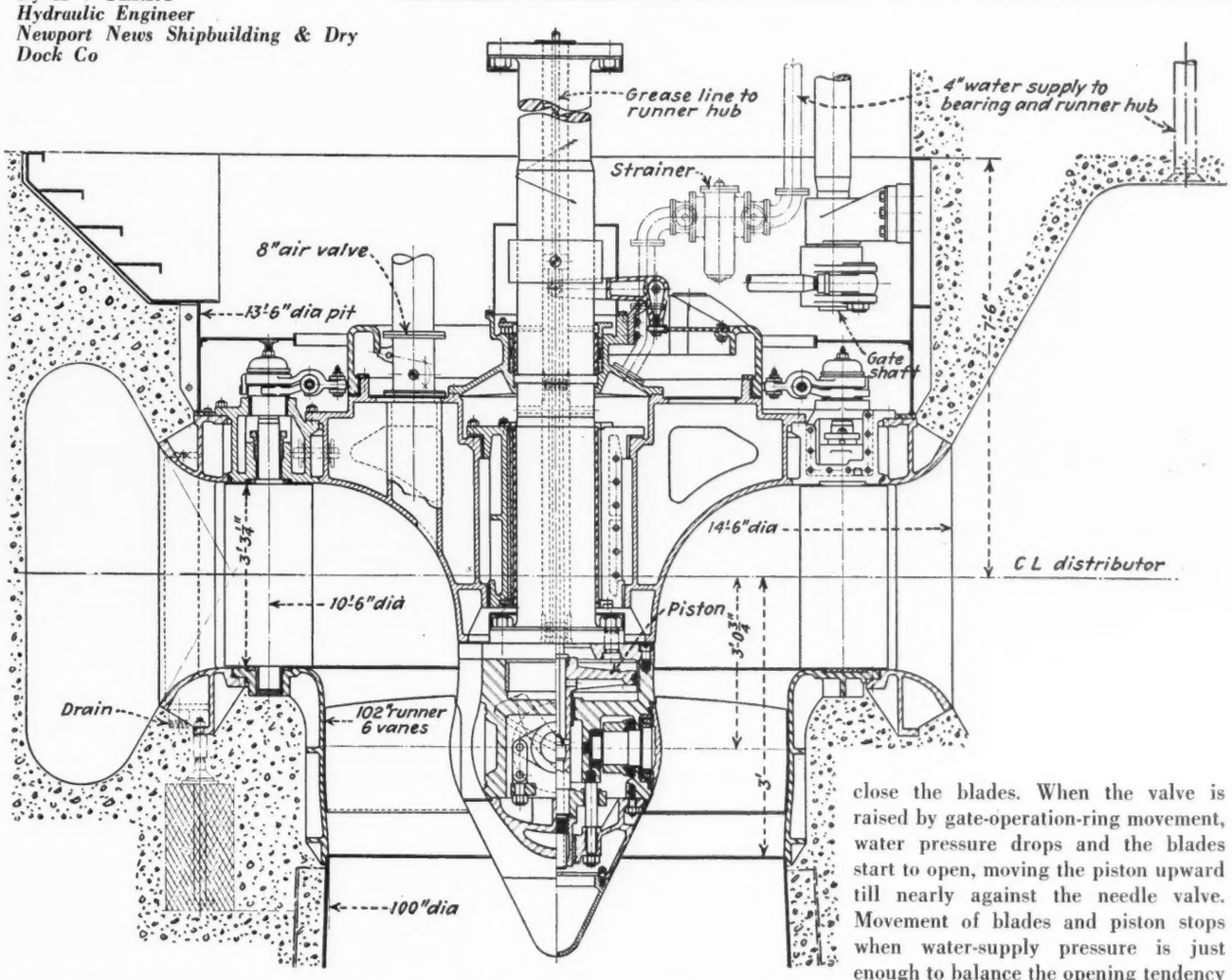
The 46⅜-in. hub diameter represents 45.5% of the nominal runner diameter. The hub is divided into two compartments; the lower one houses the blade trunnions, bearings and interconnecting links and is grease-packed.

The spider is secured to a piston rod which extends up into the upper compartment and connects to the balance piston. This top hub compartment has a bronze liner and is capped by a cast-steel cover connected to the turbine shaft. The lower hub cover, which supports a guide bearing for the piston rod, is bolted at its periphery to the hub and is also secured by six large stay bolts, two of which serve as guides for the blade-connecting spider. These

Efficiency

This is one of the few adjustable-blade hydro-turbine installations ever given an exhaustive field test for efficiency. Together with complete operating experience and design details, these data make this report on the Austin Dam hydro plant of unusual engineering interest

By H V TERRY
Hydraulic Engineer
Newport News Shipbuilding & Dry Dock Co



stay bolts transmit some of the large loads on the inner bearings to the lower hub cover and thereby increase the rigidity of the hub.

Water at a maximum of 35 lb per sq in. pressure, supplied to the top of the balance piston, always tends to close the blades, thus counterbalancing the effect of water flow through the runner which tends to open the blades. Water is supplied from the spiral casing through a motor-driven booster pump and twin strainer to the bearing housing. From there, some of the water flows through the main-shaft rubber guide bearing. At the same time, pressure is supplied through radial holes and a central hole in the shaft to the top of the balance piston. Space under the balance piston, in the upper compartment of the hub, communicates with the draft tube through ports in the piston rod and lower runner cap.

Control of blade position on higher-head plants with this type of runner requires variable pressure on top of the balance piston for best relation between wicket gates and runner blades. This is obtained in the Austin turbines by a 5-in. needle valve, at the top center of the piston, connected to the operating ring of the turbine. Operation of this device is practically identical with that of a similar one used successfully for years to operate pressure regulators or relief valves on high-head hydraulic turbines. The needle valve connects to the operating ring by a cam, double-lever, collar on the main shaft, and a vertically moving rod in the lower end of the turbine shaft. This valve has a stroke corresponding to that of the main piston.

With the valve seated against the piston, the full 35 lb per sq in. water-supply pressure acts on the piston to close the blades. When the valve is raised by gate-operation-ring movement, water pressure drops and the blades start to open, moving the piston upward till nearly against the needle valve. Movement of blades and piston stops when water-supply pressure is just enough to balance the opening tendency of the blades. This device is arranged so that the runner blades stay in their flattest position until 30% gate opening is reached. Above that gate opening, it allows the blades to open until at 80% gate, when they are fully open. Thus the blades are always positioned at their most efficient angle to correspond with the gate opening.

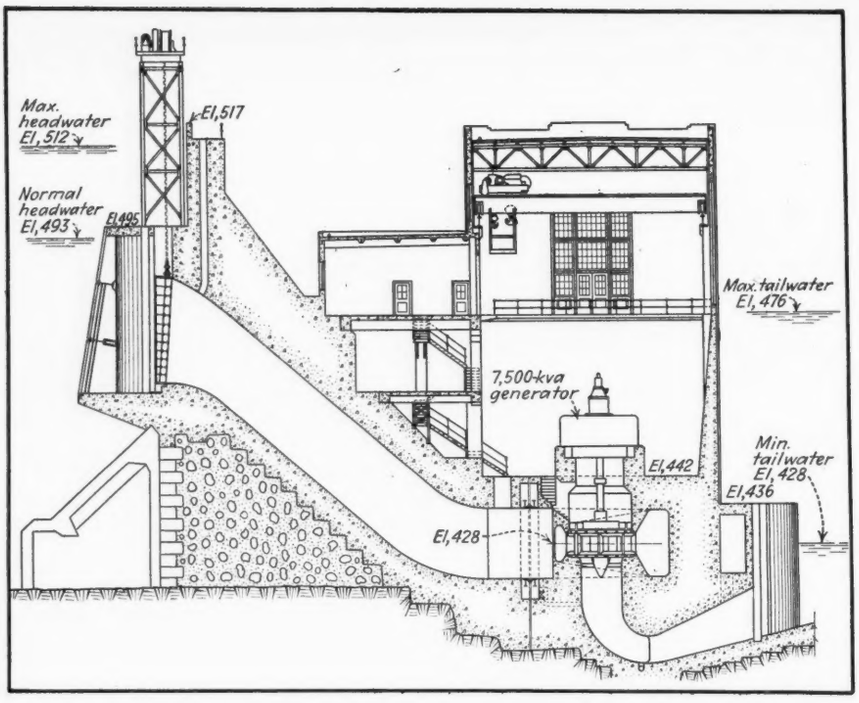
The runner blades have a total angular travel of 25 deg limited by the stroke of the balancing piston. Variation in blade position for a given gate opening, between increasing and decreasing load, is negligible, being from 0 to 0.5 deg.

Starting the turbine from rest greatly increases the opening tendency of the blades, because of the manner of water impingement. Under this condition the maximum supply pressure on the piston is insufficient to balance

the opening tendency. As a result, the blades open, moving the piston and needle valve upward, away from their normal positions as dictated by the position of the gates. This results in the same high starting torque and low thrust on the main thrust bearing as for the Marmet installation. As the unit starts and picks up speed the opening tendency of the blades reduces until they are closed by the pressure on the reactive piston.

A somewhat similar action takes place if the machine overspeeds. As overspeed increases, tendency for the blades to open increases rapidly, overbalancing the reactive pressure, causing the blades to move open away from their normal gate-blade relation. In the case of overspeeds, a moderate gate opening is sufficient to make the blades open to their full pitch. This action results in a greatly reduced maximum runaway speed, which is only about twice normal compared to a possible value of 2.3 to 2.5 times normal without this feature.

Normal forces acting on the blade-operating mechanism in the runner hub are rather low, due to the peculiar method of pivoting the blades and to the limited pressures applied to the balance piston. This mechanism is, however, designed for much larger forces that may occur under certain conditions of overspeed.

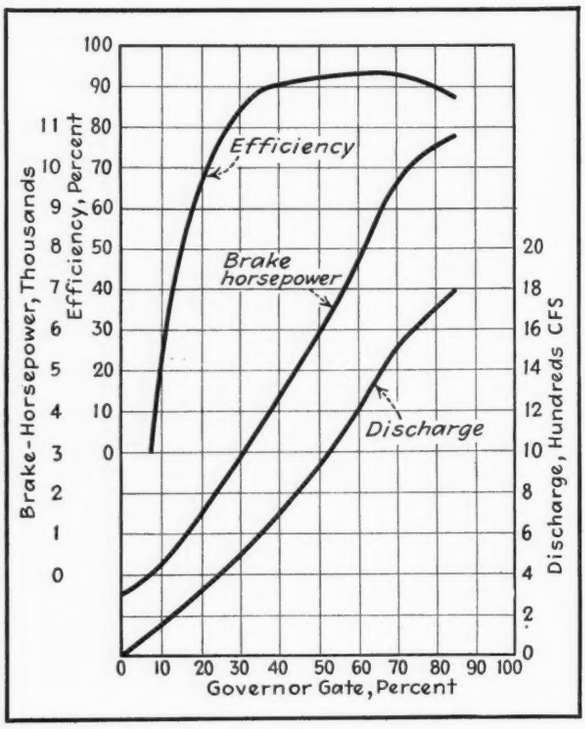


Each turbine drives a 7500-kva Westinghouse generator and is governed by a 60,000-ft-lb Woodward governor of the torsional-gate-shift, cabinet type, with permanent magnet generator drive for the flyball motor. System capacity is about 170,000 hp, with a total flywheel effect of about 60,000,000 ft-sq-lb. Capacity of the Austin units is about 12% and their flywheel effect is only 6% of the system's total. However, because of their excellent governing characteristics and their flat power-efficiency curves, these units are used for system-frequency control

Field tests on the Austin units, made in January of this year, are comprehensive and accurate. Discharge was measured by the Gibson method. In the curves at right (results of tests on No. 2 unit), turbine discharge, brake horsepower, and efficiency at 61-ft net head, are plotted against the gate opening on the governor dial. A maximum efficiency of 93% was obtained. The efficiency curve is unusually flat, being about 90% from 38 to 79% gate, or from 4200 to 10,400 hp, a range of 62% of rated load. The average efficiency obtained from 20 test points, within the guaranteed range of from 4000 to 10,000 hp, was 91.6%. These results are as good as any ever obtained with adjustable-blade turbines during the 25 years of its development.

Average efficiency of a corresponding fixed-blade, propeller-runner turbine from 40 to 100% rated load is about 83%, or 8.6 points less than for adjustable-blade turbines. Moreover, capacity of the adjustable-blade turbine for the Austin conditions is about 18% greater than a normal design of fixed-blade turbine of the same size.

A gate opening of 7.5% is sufficient to bring the unit up to speed. At that gate opening the discharge is about 125 cfs, or only 8% of the discharge at rated load. For a fixed-blade propeller turbine of the same rating, the discharge required to bring the unit up to speed would be about 390 cfs, or over three times that of the adjustable-runner.


Brake-Horsepower, Thousands
Efficiency, Percent
Discharge, Hundreds CFS
Governor Gate, Percent
Efficiency
Brake horsepower
Discharge
0 10 20 30 40 50 60 70 80 90 100
0 1 2 3 4 5 6 7 8 9 10 11
0 2 4 6 8 10 12 14 16 18 20

When any load up to full-rated value is dropped, the runner blades and wicket gates close in approximately the same time, the blades lagging the gates somewhat compared to their normal relation. Automatic valves admit atmospheric air through the crown plate above the runner up to 17.5% gate opening, to reduce the uplifting tendency on the runner blades, and consequently the rotor.

The units motor quite well with the wicket gates closed. Although runner blades are submerged, they remain closed when motoring and air is admitted through the crown plates. Under this condition, power required to drive the runner at normal speed was found to be 450 hp, or 4.5% of the rated load.

AUSTIN-DAM HYDRO PLANT OPERATING EXPERIENCE

Operating experience has shown some blade pitting. Slightly over half the area of the back side of each runner blade was originally protected by a layer of stainless steel to prevent pitting. Some pitting occurred on the unprotected areas, which have since been welded with stainless.

The centerline of the runner blades is only about 4 ft 6 in. below tailwater level. No pitting has occurred on the throat ring, although that part was not protected by stainless. Absence of pitting on the throat ring is attributed to the location of the gate tips, when in their full-load position, with respect to the curvature of the throat ring. Gate tips do not overhang the curved portion of the throat ring, although ratio of diameter of wicket gate circle to throat diameter is rather low.

The machines begin to get noisy at 85% gate, indicating the beginning of cavitation. Normally the gate opening is limited to 80%, above which there is very little increase in power as the efficiency falls off rapidly from that point.

Grease first used in the runner hubs proved to be too soft and was lost from the hubs rather rapidly. A much stiffer grade of grease, waterproof and very adhesive, is now used.

The Austin units were placed in service in April, 1940. They have been operating satisfactorily and almost continuously since that time and on occasions have operated at full-load for a period of two weeks.

Outside of the special runners, and a small amount of extra equipment in the turbine pits, the turbines are of standard construction, the same as for fixed-blade propeller turbines. Main-shaft coupling connection to the generator is of standard proportions. Generators and governors are standard, in that no extra equipment is required for the automatic turbine feature, except that of providing a hole in the generator shaft and a mounting at the top of the generator for runner-blade position indicator.

✦ ✦ ✦

Safety Standards for Operating Platforms

Steel platforms should provide access to all points of regular operating or maintenance attention. Attention to standardized details offers safety as well as minimum construction cost, says W Elwood Rossnagel, Safety Engineer, Consolidated Edison Co of N. Y.

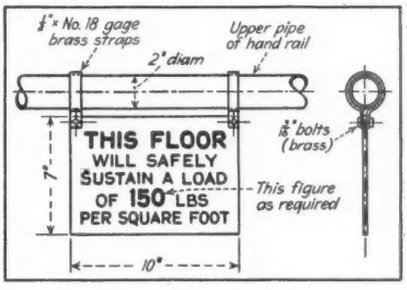

¼" x No. 18 gage brass straps
Upper pipe of hand rail
2" diam
THIS FLOOR WILL SAFELY SUSTAIN A LOAD OF 150 LBS PER SQUARE FOOT
⅜" bolts (brass)
This figure as required
7"
10"

Fig. 1 — Porcelain enameled signs attached to upper pipe handrail at conspicuous locations avoid any misunderstanding of safe floor load

▶ In power plants, gas works, chemical plants, coal pockets, ready-mixed concrete plants and at numerous other locations steel platforms are provided for safe and convenient access to the various points of operation, such as boiler controls, valves, and conveyors. In order to afford the proper safety, not only for the men working upon them but also for those working or passing below, certain rules have been adopted for the design of these platforms.

In the following paragraphs an attempt is made to standardize for the designing engineer and draftsman the proper design of platforms from a safety viewpoint. Many of the dimensions given, such as the height of handrails, are specified in state labor laws and city building codes. On the other hand, some of the rules are the result of practical installations and some of the figures are arbitrarily determined.

All platforms should be of ample strength to support safely the maximum live load expected to be placed upon them. Small platforms for access to ordinary valves are often figured for a live load of 50 lb per sq ft. On the other hand, large platforms upon which heavy pipe fittings may be placed during construction or operating periods should be figured for 150 lb per sq ft. Where local building codes cover construction of this type, they should be given prior consideration.

Porcelain enameled signs attached to the upper pipe of platform handrails at conspicuous locations avoid any misunderstanding of safe floor load. All platforms should be rigidly supported structurally and braced against possible side-sway. Platforms should not be suspended by rods and beam clamps such as are used for pipe hangers.

All platforms should be at least 24 in. wide, the width being dependent upon the requirements and the local conditions. Where a platform or any portion of a floor is 20 in. or more above the adjacent flooring, standard handrails should be provided. If 6 ft or higher, toe plates should be attached to the handrails to prevent tools and other objects from rolling off the platform and injuring a man below.

A standard handrail is 42 in. high above the floor, and has an intermediate rail about 22 in. high. The horizontal members are frequently of 1½-in. standard-weight steel pipe, while the stanchions are 1¼-in. pipe and spaced not more than 7 ft apart. The stanchions are usually screwed into the crosses and tees while the horizontal members pass entirely through these fittings which are reamed to proper diameter. Fig. 2 shows various types of railing brackets and Fig. 3 the different railing fittings. The rails are joined by means of couplings, and pins are driven through the pipes at all fittings as shown in the arrangement sketches in Fig. 2.

As an alternative for outdoor platforms, particularly in gas works and chemical plants where corrosion is very rapid, handrails are sometimes constructed of solid bars and rods instead

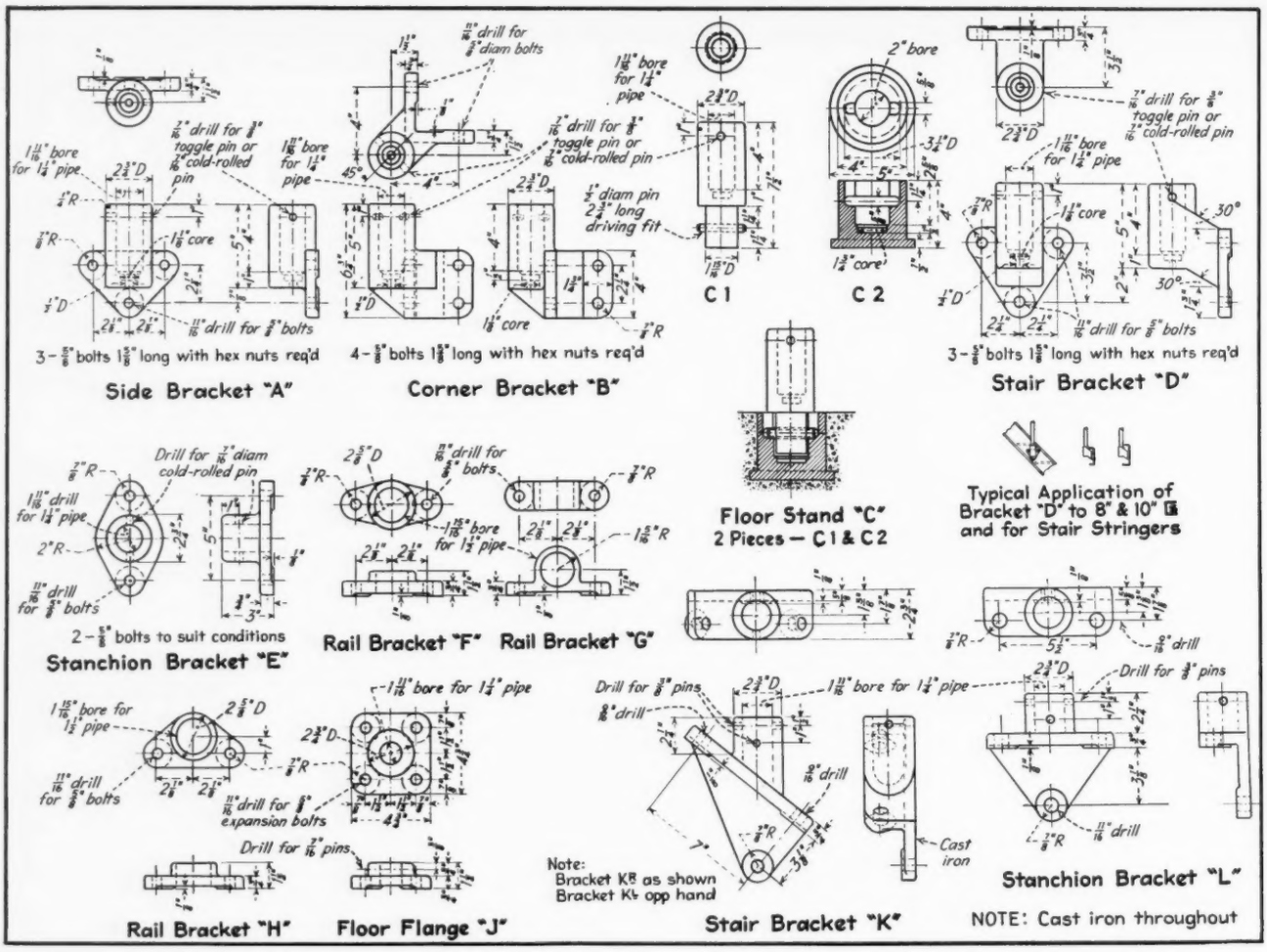


Fig. 2—Several types of bracket for supporting railings. Stanchions are usually screwed into fittings, pinned into brackets

of pipe (POWER, March, 1941, page 71). Rods are spot-welded to each stanchion to give the necessary rigidity. With this type of construction, the spacing of the stanchions should not exceed 6 ft. The bar-and-rod type handrail should be ended by terminating the rods in the stanchions or by extending the upper rod about a foot beyond the last stanchion and then by means of two 90-deg bends welding it to the projection of the lower rod. Rods, whether capped or not, should not otherwise extend beyond the last stanchion.

Toe plates should be installed along all edges of elevated platforms except where the edge of the flooring is 1 in. or less away from a wall or other object, which would thus limit to less than 1 in. the size of tool which might roll or be accidentally kicked off the platform. Toe plates should always be provided under the bottom step of a stair going up to the level above, but should be omitted at the access side of a ladder well as there is less danger of a serious accident due to a falling tool than if a man should trip over the toe plate while attempting to get onto a ladder.

These toe plates are usually ¼ in. thick and 4 in. high above the surface of the flooring. Usually they are steel plates about 9 in. wide riveted to the back of the channel section which supports the flooring. While as a rule the stanchion brackets are bolted to the toe plate there are some installations in which the stanchions are secured to the channel and the toe plate in turn fastened to the stanchions. Stanchions should always be mounted on the side of the toe plate away from the platform.

Where pipe risers pass through flooring, if the annular space between the edge of the flooring and the pipe exceeds 1 in., either a toe plate should be provided or a sheet-metal collar placed around the pipe to prevent the passage of tools or other objects. If the edge of a platform is 8 in. or less from a wall or other object, a handrail is not required although a toe plate is. However, in such cases it is preferable to close up the space with sheet metal. Where a platform passes in front of large windows which extend above and below it, handrails or other protection should be provided to prevent men from falling through the space between the toe plate and the sash.

All floors and platforms should be even and without any obstructions which might present a tripping hazard, yet the surface should be rough enough to prevent slipping. For large floor areas, concrete with a granolithic finish is very satisfactory. For platforms, checkered plate or any of a wide variety of modern gratings is acceptable, provided the clear openings in the gratings are small enough to prevent the passage of a $\frac{15}{16}$-in. ball. If the opening in the grating is rectangular in shape, the length of this space should not exceed 5 in.

All gratings should bear upon their supports by not less than 2 in. and the temporary removal of one section of grating should not allow an adjacent section to shift and slip off its support. Ordinarily, on long platforms the gratings will run cross-ways and are thus held in position by the two toe plates.

Where large areas of grating are required and adjacent sections bear upon the flange of a common beam it is good practice to weld a length of steel bar,

about 1x¼ in. on edge, along the center of the top of the beam, or small angle lugs may be welded onto the under side of the gratings so as to bear against the toe of the beam flanges and thus hold the gratings in place. Curb plates, which are similar to toe plates except that their top edges are flush with the grating surface, should be provided at the head of all stairs and at the access side of ladder wells.

In chemical plants, wood grating or planking is commonly used an platforms. As the span is usually short the quality of the wood need not be as high as would be required for scaffold purposes.

Headroom on floors and platforms is important. The general rule is to provide 6½-ft headroom on all floors and on main platforms, and 6¼ ft in secondary locations, such as blind alleys behind boilers, dead-end platforms, etc. This rule is far easier to make than to enforce as local conditions frequently limit the headroom to less than 6 ft. In fact, in some plants men may consider themselves lucky if they can even crawl under pipes and obstructions.

Where low-headroom conditions cannot possibly be avoided, the offending beam or pipe should be softly padded and then wrapped with light-weight canvas, and this padding then painted with alternate 2-in. black and white diagonal stripes on a 45-deg angle. Of course, illumination should be adequate to make this and other hazards visible.

In some instances it may be desirable to provide tell-tales similar to those used to warn men on top of freight trains when they are approaching a low bridge or tunnel. These warning devices should be placed about three or four feet each side of the low beam or other hazard to warn those approaching it. They are usually made of sash cords or sash chains spaced about 3 in. apart and having the knotted lower ends about 3 in. below the obstruction.

Occasionally a valve on a large overhead pipe is inverted so as to be readily operated from the floor or platform, and in this position the hand wheel presents a head hazard. Or, if the large valve is in a horizontal position with the hand wheel above the railing of the platform, the rising stem may periodically present a head or body hazard. To remedy these conditions it is customary to erect short lengths of standard handrails crossways on the platform directly below the valves to form effective barricades.

As far as possible, have each floor or platform at one elevation only. Occasionally, however, conditions require that one portion of the flooring be, say, a foot above the remainder, thus presenting a tripping or falling hazard. While such a condition does not warrant a handrail along the edge of the upper level, yet it is necessary to attract attention effectively to the step. This

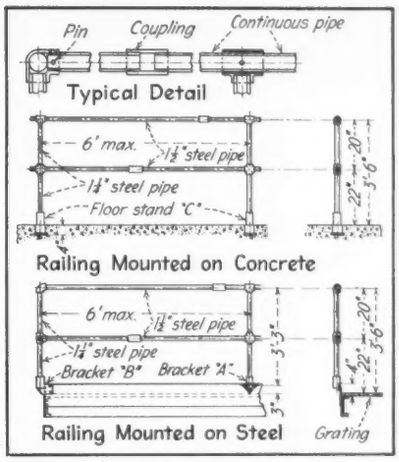


Fig. 4—Assembly of railing elements shows detail of floor mounting, elbows, crosses and couplings applied to simple straight section

may be accomplished by painting a band of white on the upper floor near the edge, or by substituting a narrow piece of checkered plate for grating, or in various other ways. If the floor is of concrete, a narrow ribbon of traffic marker inserts is suggested.

When gratings or checkered plates must be removed frequently, as at hatches, special attention should be given to securing them against falling while being handled. Hatch covers should be held in the open position against accidental closing. If the covers are 36 in. or higher when open, they may be considered adequate protection. Single spreader bars are usually provided to hold the two covers open, but inasmuch as they are usually 4–6 in. in from the edges of the covers they do not afford the necessary protection. The use of a wire screen in an angle-iron frame which may be suspended from the spreader bar and bearing against the edges of the open covers is suggested, as it will take the place of an intermediate handrail member and a toe plate. If the covers are less than 36 in. high when open, then a portable barricade 42 in. high should be placed at all four sides of the hatch. These barricades should be secured against accidental displacement or upset. Handles on hatch covers should be flush or depressed.

The subject of platforms is so vast that it is impossible to cover more than the most important facts. Each platform will have its own peculiarities and it will be found necessary to make exceptions to many of these rules. Nevertheless, these standards will go a long way toward bettering the design of operating platforms and at the same time incorporate certain features of utmost importance from a safety viewpoint.

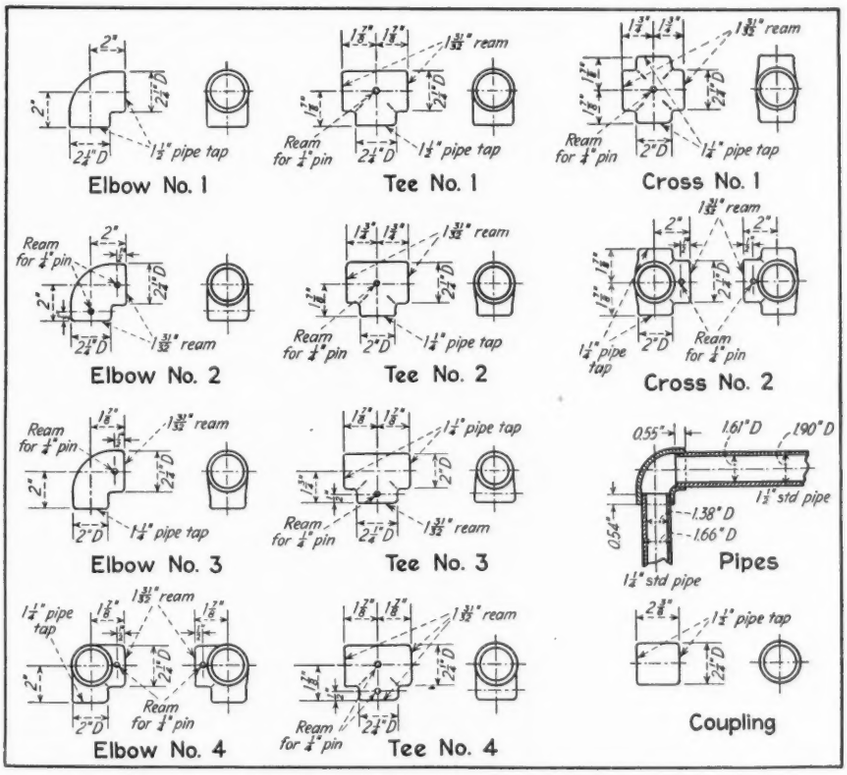
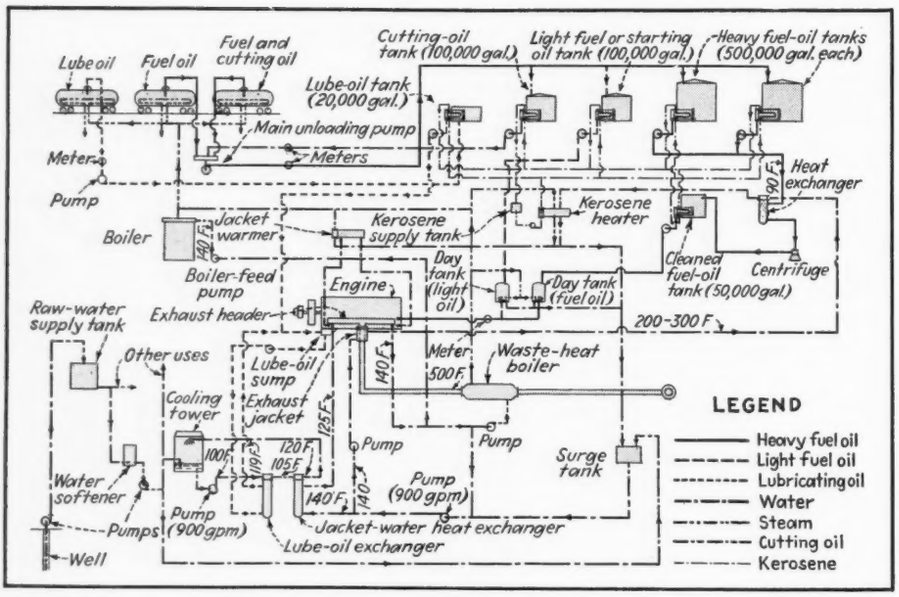


Fig. 3—Pipe handrail fittings of malleable iron are threaded, reamed for sliding fit and drilled for ¼-in. pin to facilitate erection

New Diesel Plant Iowa's Largest

Unique fuel-oil handling system using kerosene as heating medium marks 5000-kw gas-diesel standby plant on Iowa Electric Light and Power Co system, described by John M Drabelle, Consulting Engineer



Oil-heating system and cooling-water circuits

▶ THE IOWA ELECTRIC LIGHT AND POWER CO has under construction near Marshalltown, Iowa, the largest diesel-engine station yet built in that state. It will consist of two 2500-kw units with provision in the building, piping and other facilities for the addition of a third generating unit. Located approximately one mile east of the corporate limits of the city of Marshalltown, the site adjoins the tracks of the Chicago Great Western Ry, which has a direct line to Kansas City, with connecting rail lines into the Group-III oil fields of the southwest.

Station Site

The station site consists of approximately 20 acres. The side track facilities will permit spotting five or six tank cars at the unloading dock for handling and a spur track runs into the station for ease and convenience in unloading material and plant equipment. Tank-car heating facilities will expedite unloading of heavy fuel oils.

The storage tanks are in the northeast section of the site in an area 300 x 460 ft; facilities are provided for both fuel and lubricating oils. The initial installation consists of two 500,000-gal heavy-oil tanks, a 100,000-gal medium-heavy-oil tank, a 100,000-gal. light-oil tank, a 50,000-gal centrifugal-fuel-oil tank, and a 20,000-gal lubricating-oil tank. Space is available for duplication of these units.

As the diagram indicates, piping arrangements at the tanks permit buying No. 5 or No. 6 oil when market conditions are favorable and mixing it, using heat and recirculation, with No. 3 oil to produce a blended fuel easier to handle in the engine injection gear and through the various pumps and tanks in the station.

Separate dikes with sufficient area around each tank protect against oil spreading in the event of tank failure, meeting the requirements of the National Board of Fire Underwriters.

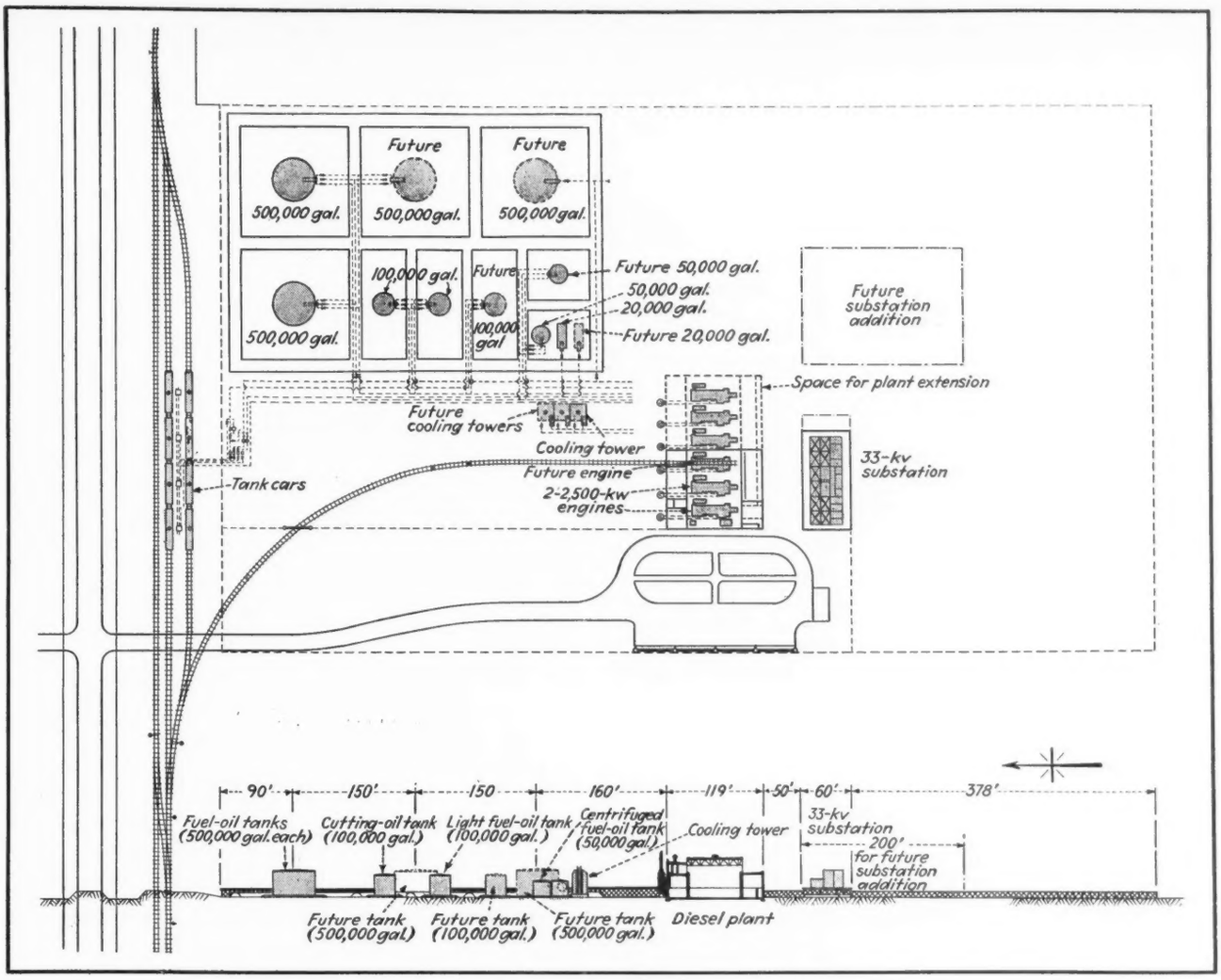
The over-all dimensions of the building are 95 ft east and west and 117 ft north and south. The main engine room has a span of 72 ft with an additional space of 20 ft for various items of plant equipment and an extension of 20 ft to the south in which is housed electrical gear. Basement floor line runs 4 ft below average grade of surrounding land; basement floor-to-ceiling height is 14 ft. A clear height of 28 ft from engine-room floor to crane rail permits piston pulling; total height of engine room proper is 53 ft. Building walls are concrete to a height of 2 ft above grade line and the balance of the structure is brick. The roof will be of gypsum covered with composition roofing. Low winter temperatures (as low as 35 F below zero) necessitated use of insulating material in the roof to avoid excessive heat loss from the large exposed surface.

Generating units consist of two Nordberg gas-diesel engines, each rated at 3600 brake hp when operating at an elevation of 1000 ft above sea level. The nine power cylinders are 21 in. diameter by 29 in. stroke and operate at 225 rpm. Each engine is direct connected to a 2500-kw generator with a 40-kw shaft-driven exciter.

Full Diesel Cycle

The engines are designed to operate on the full diesel cycle using either oil or natural gas with pilot oil for ignition. These engines are the latest development of the Nordberg Mfg Co and are equipped with the Curtis liner which gives them excellent scavenging characteristics when operating on either gas or straight fuel oil. The guaranteed heat rate is 10,500 Btu per kwhr. The engines are equipped with 3-stage compressors which raise fuel-gas pressure to 1000 lb. Positively operated needle valves inject fuel into each cylinder. These valves have a variable lift under direct governor control.

Because of the peculiar slow-burning characteristics of natural gas, it is necessary to inject a small quantity of light pilot oil into the cylinder at the time the needle valve lifts. This provides ample flame. The amount of pilot oil required approximates 5% of the



Plan of storage facilities, plant building and outdoor substation; note provision for expansion

total heat required by the cylinder. The engines develop full power at about 70 lb per sq in mean effective pressure; they operate on the 2-stroke cycle. Each engine is equipped with two 60-cu-ft starting-air receivers together with necessary air-compressor set and blast-air set.

Intake and exhaust mufflers (Burgess) reduce noise. On each unit, American Air Filter Co multi-panel automatic air filters, with electrically driven actuating mechanism, clean combustion air. A waste-heat boiler and a small separately fired boiler are provided to heat the building and supply other heating needs.

The closed cooling system consists of a Schutte & Koerting shell-and-tube water-to-water heat exchanger for the jacket circuit and a similar exchanger for lube-oil cooling. The usual complement of circulating pumps is provided, each engine being considered a complete unit in itself. A Foster Wheeler induced-draft cooling tower having a capacity of 1800-gpm handles raw-water cooling. The schematic piping diagram shows the hookup.

One of the most troublesome factors in some diesel-power-station operations is the heating and handling of fuel oil. For this purpose a heating coil is provided in each tank, using kerosene instead of water as the heating medium.

Kerosene Heats Oil

This unique arrangement eliminates danger of freeze-ups during severe winter conditions when the plant is operating as standby. The kerosene supplying the actual heat to the tank coils circulates on the tube side of a heat exchanger, with heated water on the shell side. Heat in the water is supplied by a combination of the exhaust-gas boiler, the jacket-water heat exchanger, and the lube-oil heat exchanger. Water-cooled exhaust manifolds supply heat to an exchanger warming fuel oil entering the Sharples centrifuge.

During cold-weather operation when engines are standing by, a jacket-water warmer, supplied with steam from the station heating boiler, maintains jackets at proper temperature for instant starting. In the station proper are mounted the usual day tanks, both light and heavy fuel for starting and pilot operation; also heavy fuel for regular operation when gas is not available.

The main station water supply comes from a deep well which feeds a raw-water tank. After passing through a softening system, the water goes to the cooling-tower basin and to other station uses.

This station will normally operate for voltage regulating and standby service on the main trunk system of the Iowa Electric Light and Power Co. Initially it will operate on base load, but when certain transmission-line facilities are provided it will then be operated for regulated standby and emergency purposes. The electrical gear is of the conventional 2300-volt, 3-phase, 60-cycle type. An outdoor substation provides switching for three 33-kv lines and later will tie-in with the main 115-kv trunk backbone of the system.

Sweet-Running Belts Require Correct Tension

If you are an engineer who has suffered headaches from trying to solve the problem of achieving correct belt tension, you will welcome these three solutions on short-center drives

By JAMES ADAMS, JR
Engineer, Manhattan Rubber Manufacuring Co

▶ PROPER TENSION, one of the prime essentials in all belt drives, is under complete control of the purchaser. The manufacturer cannot sell it with his belt; he can only suggest politely the proper amount and how to obtain it.

A time-honored rule-of-thumb for achieving proper belt tension is to measure with a tape line the length of belt necessary to connect the two pulleys, then deduct ⅛ in. for each foot of belt length. This rule works out fairly well on long belts where elasticity compensates to a degree for belt stretch, so that take-ups are necessary only at fairly long intervals.

Many flat belts in use today operate on short centers and generally have some form of automatic take-up for tension control. Such equipment falls into three general divisions: idler pulleys and two types of pivoted-motor and tension-control motor bases. Automatic tension and take-up control on a belt running on fixed-center pulleys can be obtained with a floating idler pulley, Fig. 1. The idler is pressed against the belt by various means, such as a weight, Figs. 1 and 4, by a spring, Fig. 5, and in some cases by a hydraulic device.

Besides providing tension control for a belt operating on fixed centers, a properly installed idler will allow the belt to deliver greater horsepower per pound of load on the bearings than any other type of belt-tension regulator. By adjusting the idler position, you can correct for a certain amount of pulley misalignment. This is important with wide flat belts that do not respond readily to pulley crowns or which would be injured by excessive crowns.

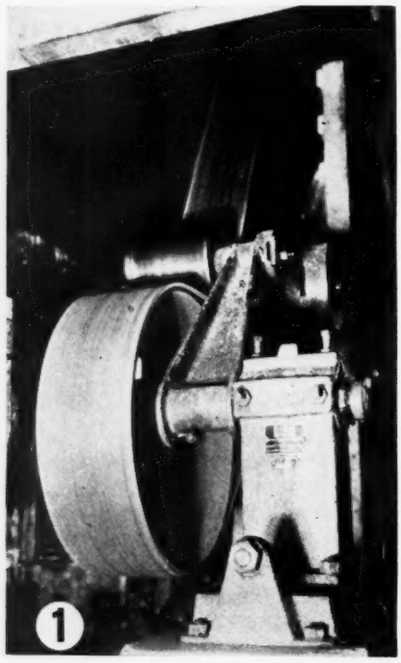
Some idlers have received notoriety as "belt killers", which is a true statement if they aren't properly installed and adjusted. A first-rate installation has the idler on the slack side of the belt, Fig. 4. Loading on the idler is adjusted to put the minimum tension on the belt required to drive the maximum load without slipping. In this way, as load increases and the tight-side stretch of the belt is transferred to the slack side, the idler drops to a lower level, depending on the amount of belt stretch. This action of the idler maintains slack-side tension practically constant and increases the arc of belt contact on the small pulley to give more driving power.

Practical Pointers

Here are some practical pointers for getting good results with idlers:

1. To minimize the effects of reverse-bending the belt around the idler, select an idler as large or larger than the small pulley on the drive.

2. Use a flat-surface pulley as an idler. With a crowned idler, the belt will flex transversely across the surface of the small drive pulley and in the opposite direction over the surface of the idler. Moreover, as the idler is



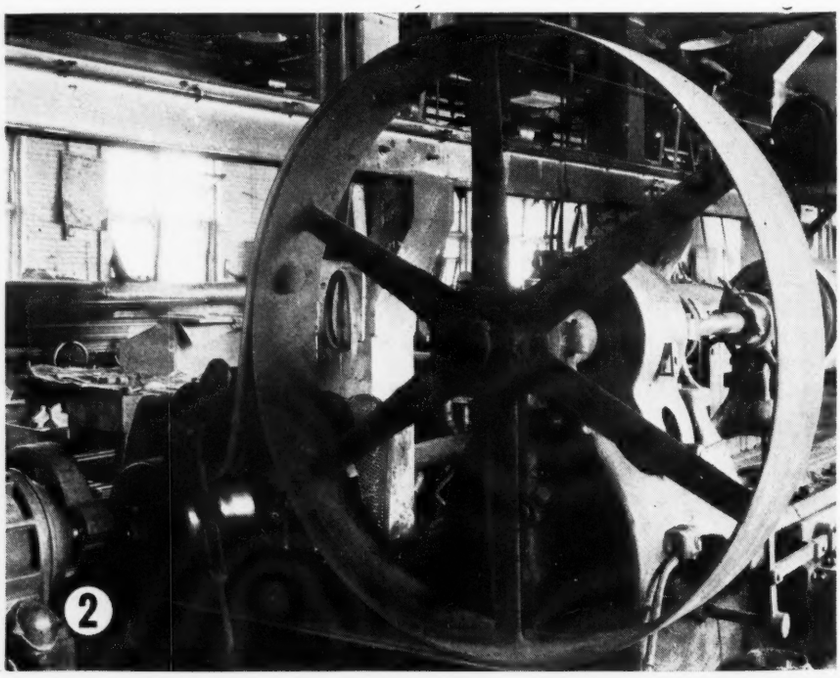


Fig. 1—Floating idler maintains tension in 8-in., 7-ply rubber belt driving trimbey screen in papermill. Fig. 2—Fixed idler on 5-ply, endless, flat-rubber-belt drive connects rubber mill to line shaft when distance between shaft centers is short

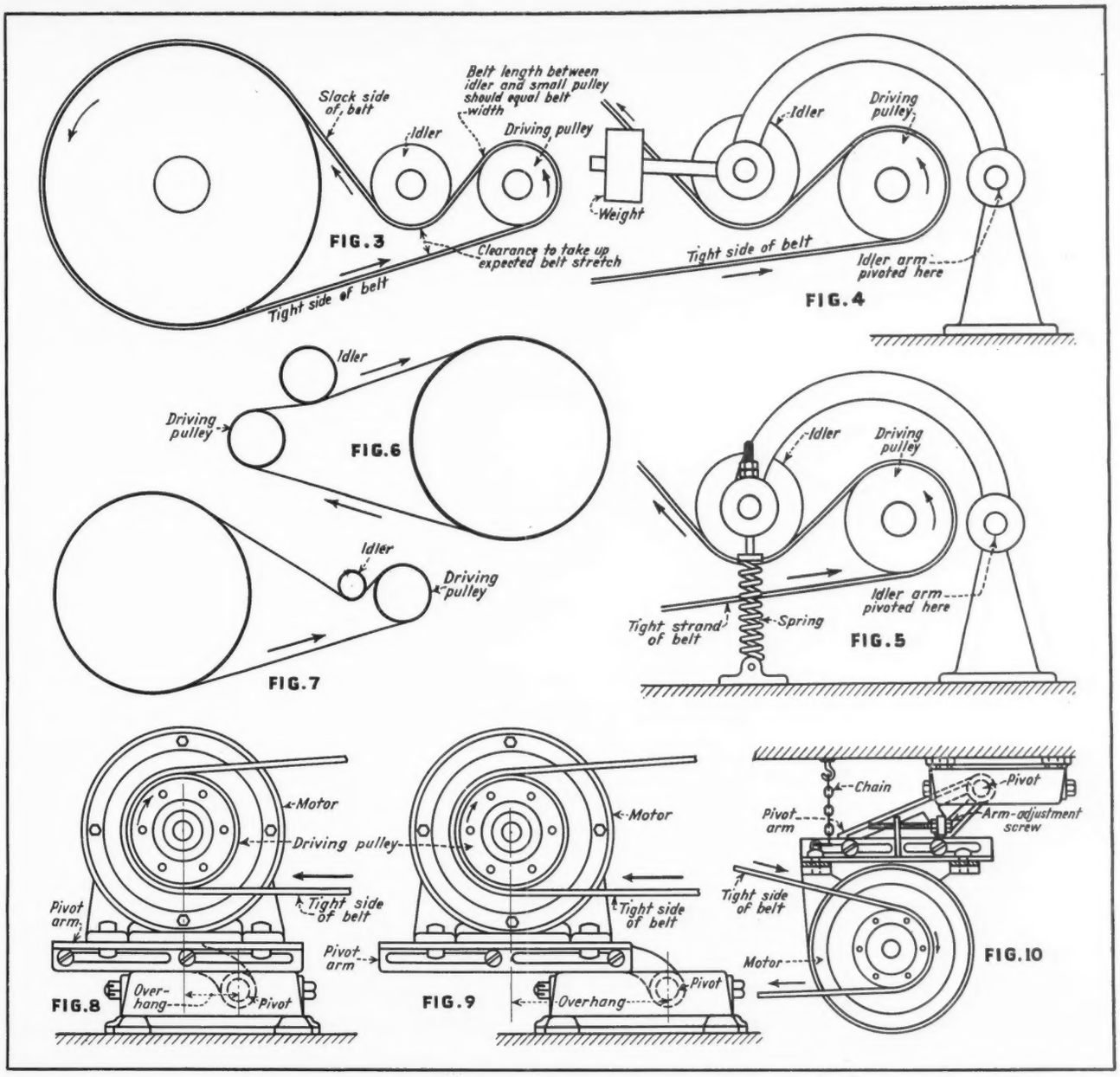


Fig. 3—Correct location of idler pulley. Fig. 4—Gravity-type floating idler. Fig. 5—Spring-loaded floating idler. Fig. 6—Idler in this position becomes a belt killer, putting excessive tension on the belt. Fig. 7—Too-small idler pulley causes undue belt bending. Fig. 8—Pivoted motor base adjusted for minimum overhang of motor on pivot arms. Fig. 9—Pivoted motor base adjusted for maximum overhang of motor on pivot arms. Fig. 10—Pivoted motor base for ceiling mounting

quite close to the small pulley, the change in direction of the flexing over the pulley crowns is very rapid and therefore aggravates the destructive effects of the bending action.

3. Adjust the center distances between the driven and driving pulleys or make the belt of such length that it will be wrapped around the small pulley and leave only a safe allowance for anticipated belt stretch, Figs. 3 to 5. If the idler is placed in the position, Fig. 6, the arc of belt contact on the small pulleys is greatly reduced compared to Fig. 3. Thus, belt tension must be increased to drive the same load.

Also, for a given weight of idler, the stresses in the belt (Fig. 6) are several times those of Fig. 3. Many cases are on record of belts breaking caused by an idler in the position shown in Fig. 6. A sudden load increase causes the idler to bounce off the belt. Then, when it hits the belt, stresses are produced great enough to break the belt.

4. Set the idler so that length of belt between idler and small pulley equals belt width. This rule has been time-tested by full experience and is practically a commandment. The farther away the idler is away from the small pulley, the less effective it is in wrapping the belt around the latter. If the idler is set too close to the small pulley, the belt wrap increases with load, but the bending stresses in the belt becomes more severe.

5. It isn't advisable to use idlers for belt speeds over 5000 fpm. If possible, use an endless belt to eliminate the effects of belt fasteners running under the idler.

When idlers are properly applied and adjusted, they permit carrying a heavier load with the same belt width and speed and same maximum belt tension than any other device. Idlers permit operation on short centers and thus save floor space. Other advantages are reduced belt slippage, increased

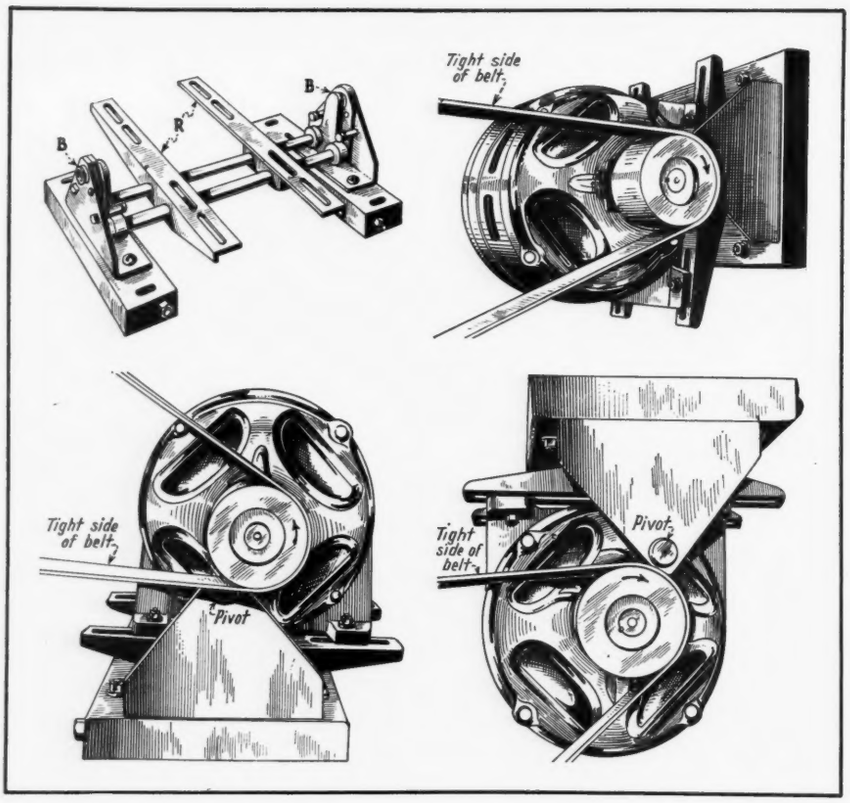


Fig. 11—Tension-control base utilizes motor reactive torque to adjust belt tension. Figs. 12 to 14—Tension-control base, with motor mounted on floor, wall and ceiling respectively, adjusts belt tension according to load

belt life because of operation with less belt tension, more contact arc on the small pulley, and possibility of increasing the ratio of pulley diameters.

Pivoted Motor Base

Gravity - type, pivoted - motor - base, short-center drives differ from the idler-pulley method in that part of the motor weight is used to maintain automatically tension on the slack strand of the belt. This drive made its debut under railway passenger cars as an axle drive for the lighting generator. Here the electric generator, hinged from the floor of the car, was free to swing to keep the belt tight.

The idea is now applied to short-center drives in the Rockwood, Browning and other motor-tension bases. It consists fundamentally of two adjustable arms on which the motor is fastened, Figs. 8 to 10. One end of the arms is pivoted and supported on threaded rods in the motor base. By turning the rods, the operator can adjust the position of the motor on its base to take care of belt stretch. Slots in the pivot arms permit regulating the position of the motor on them, Figs. 8 and 9.

The motor is positioned on the pivot arms so the center of its shaft overhangs the pivot center. In this way, the weight of the motor is used to maintain belt tension. Overhang of the motor on the pivot is one of the important considerations in applying gravity-type pivoted-motor bases.

The amount of overhang depends upon direction of belt pull and slope of drive, ratio between driving and driven pulleys, weight of motor, and peak loads to be transmitted. The greater the overhang, the more tension in the belt and the more load it will pull. Overhang should be adjusted to give enough tension to drive the peak load with minimum slippage. Fig. 8 shows the motor positioned for minimum overhang to give minimum belt tension; Fig. 9 shows both at maximum.

For best results, the tight side of the belt should be between the pulley and the pivot. As load increases and the belt stretches slightly, weight of the motor causes it to drop back slightly and take up the slack. These bases are available for mounting motors in any position, such as floor (Figs. 8 and 9), ceiling (Fig. 10) and wall with the belt running at any angle from horizontal to vertical.

Tension-Control Bases

A gravity-type pivoted base maintains practically constant tension in the belt from no load to full motor load. This tension depends principally on the weight of the motor. The tension-control base of the American Pulley Co., Fig. 11, utilizes the reactive torque of the motor to control belt tension. With this base, belt tension automatically increases with load and diminishes as the load is lightened.

Reactive Torque

The stator of any motor has just the same tendency to turn about the rotor as the rotor has to turn in the stator. The only reason that the rotor and not the stator turns in most motors is because the stator is fixed. The tendency of the stator to turn about the rotor is called the reactive torque.

This tendency is put to work in the base shown in Fig. 11. The motor is mounted on two slotted rails *R*, supported from the ends of cranks or pivots in bearings at *B*. This leaves the motor free to swing so that as load increases, reactive torque of the motor pushes the pulley back against the belt to increase its tension. When load decreases, the reactive torque and the belt tension also decrease. Satisfactory operation of this base depends upon the tight side of the belt being nearest the pivot, Fig. 12; otherwise, belt tension will decrease as load increases and defeat the purpose of the base.

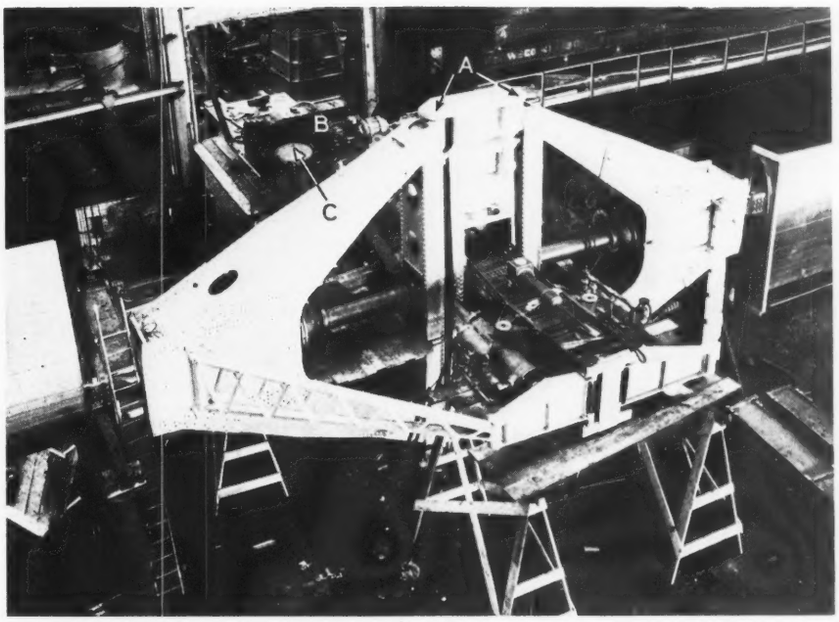
Standard bases are used for wall and ceiling drives where the tight side of the belt is at the top, Figs. 13 and 14. When wall or ceiling is not accessible for motor mounting, special top-side bases are used. These provide a floor mounting and still keep the pivot nearest the tight side of the belt. This type of drive is also recommended when the center line of the drive is vertical or within 45 deg of vertical and the driven pulley is above the motor.

Other Tension Devices

The devices so-far mentioned for control of belt tension do not cover all available possibilities. Another control, invented in 1893 but little known, is the planetary floating pulley. This consist of a floating pulley driven from a shaft by planetary gears in such a manner that as load increases the pulley pushes harder into the belt, thus regulating tension according to load. No less than six variations of this device has been patented in the U.S., Great Britain and Germany. One form of this automatic belt-tension device is now sold in this country under the name Wearn Autoflex drive.

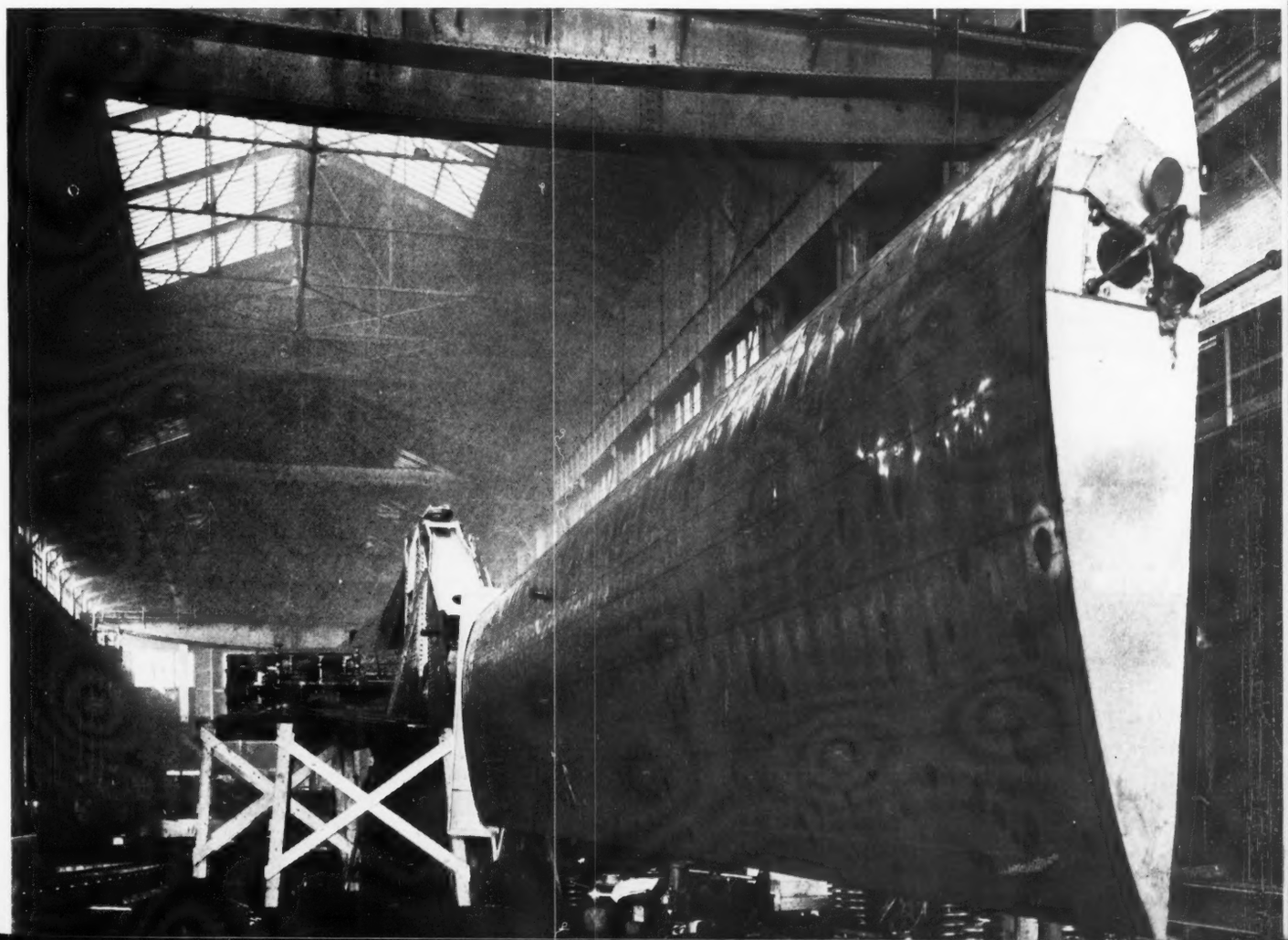
Wind-Electric Plant to Operate Soon

▶ On top of a 110-ft tower erected on Grandpa's Knob, a 2000-ft mountain near Rutland, Vt., the largest wind-driven electric-power generating plant ever built is now nearing completion. The wind turbine, one of the most interesting features of this installation, has only two blades. This turbine will operate at 28.7 rpm and its speed will be increased to 600 rpm through gearing for connection to a 1250-kva, 3-phase, 60-cycle generator, which will connect to the local power system through step-up transformers. The installation is being sponsored by the S Morgan Smith Co and the General Electric Co, and is the invention of P C Putnam, a Boston engineer. The unit is experimental but is large enough to permit adequate testing. A more detailed story of this plant will appear in June Power.

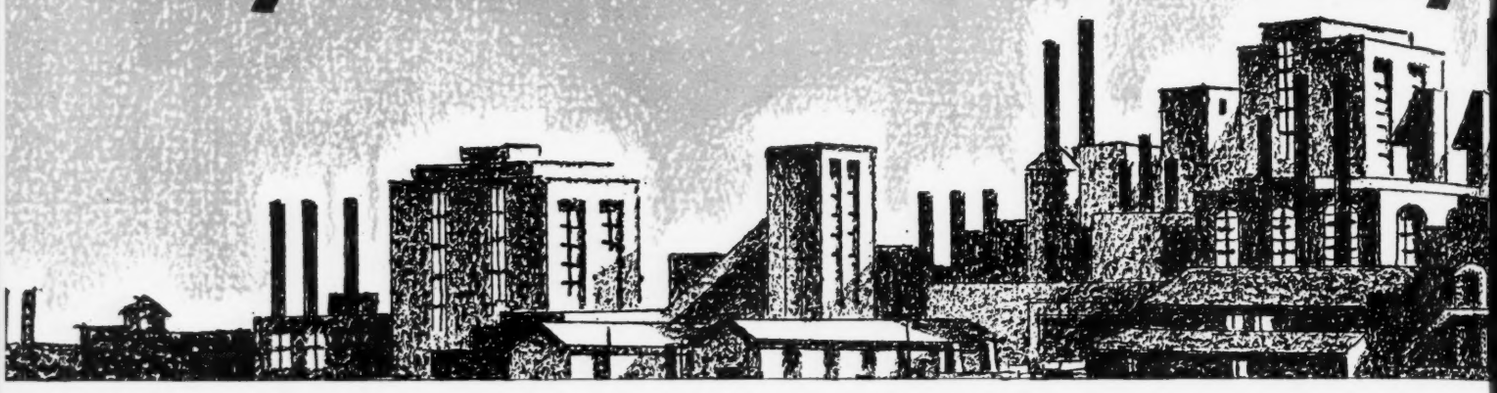


Blades are hinged at *A* and can swing downwind up to 20 deg. against restraint of hydraulic pistons. Back of the blade-hinge structure can be seen the governor-pressure-oil tank *C* and the speed-up gears at *B*

The turbine blades, like airplane wings in cross-section, are 11 ft wide by 65 ft long and weigh 15,300 lb each



Why this swING to Riley



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And guaranteed capacities are likewise invariably exceeded.
At Masonite Riley guaranteed a peak capacity of 60,000 lbs./hr. Actual 75,000 lbs.
At Allis Chalmers, 150,000 lbs./hr. was guaranteed. Actual 180,000 lbs.
At Godchaux Sugars, the guarantee was 100,000. They operate at 118,000 lbs.
At Lynn Gas & Electric they have operated at 260,000 lbs./hr. when guarantee was 205,000 lbs.

Or perhaps they were impressed by the lack of operating difficulties and ease with which Riley Units are placed on the line for the first time; with the fact that with Riley Units, it is not necessary to go through expensive repeated shut-downs for changes and adjustments; that when you light up your Riley Unit for the first time you can plan to keep it on the line. Evidence of the careful designing and thorough engineering of all Riley Units.

Then again they may have liked the general satisfactory operating characteristics of Riley Units—clean steam, absence of carry-over, steady water level, comparatively constant superheated steam

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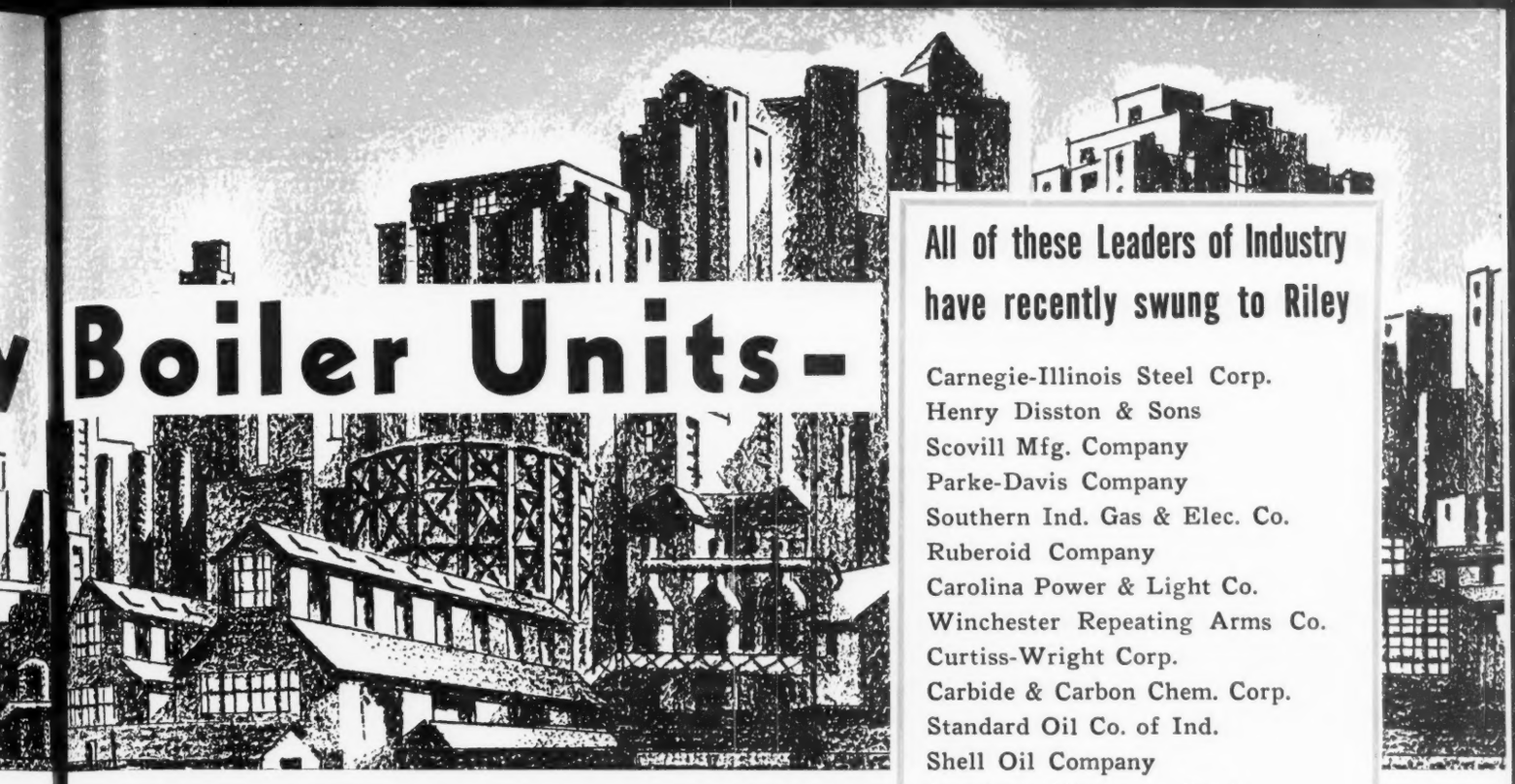

Boiler Units—

temperature, freedom from slag and other furnace difficulties, adequate response to rapidly fluctuating loads.

Or continuity of operation, reliability and low maintenance may have helped to swing them to Riley. An availability factor of over 98% can be expected with Riley Units. Positive unrestricted circulation assures against tube failures in boiler and water walls. The excellence of design of the steel-clad insulated setting practically eliminates setting repairs.

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Undoubtedly it is not because of any one of these characteristics of Riley Boiler Units but because of all of them that such a rapid swing to Riley Units has occurred. Thorough investigations have definitely proven you can rely on Riley.

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Shell Oil Company
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Humble Oil & Refining Co.
Standard Oil Co. of N. J.
Union Electric Co. of Mo.
Union Electric Co. of Ill.
American Brass Co.
American Cyanamid Corp.
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Dow Chemical Co.
Norton Company
Campbell Soup Co.
Crown Cork & Seal Co.
American Viscose Corp.
Celanese Corp. of Amer.
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General Motors Corp.
Allis Chalmers Mfg. Co.
Central Ill. Light Co.
Container Corp. of Amer.
Kellogg Company
American Steel & Wire Co.
Florida Power & Light Co.
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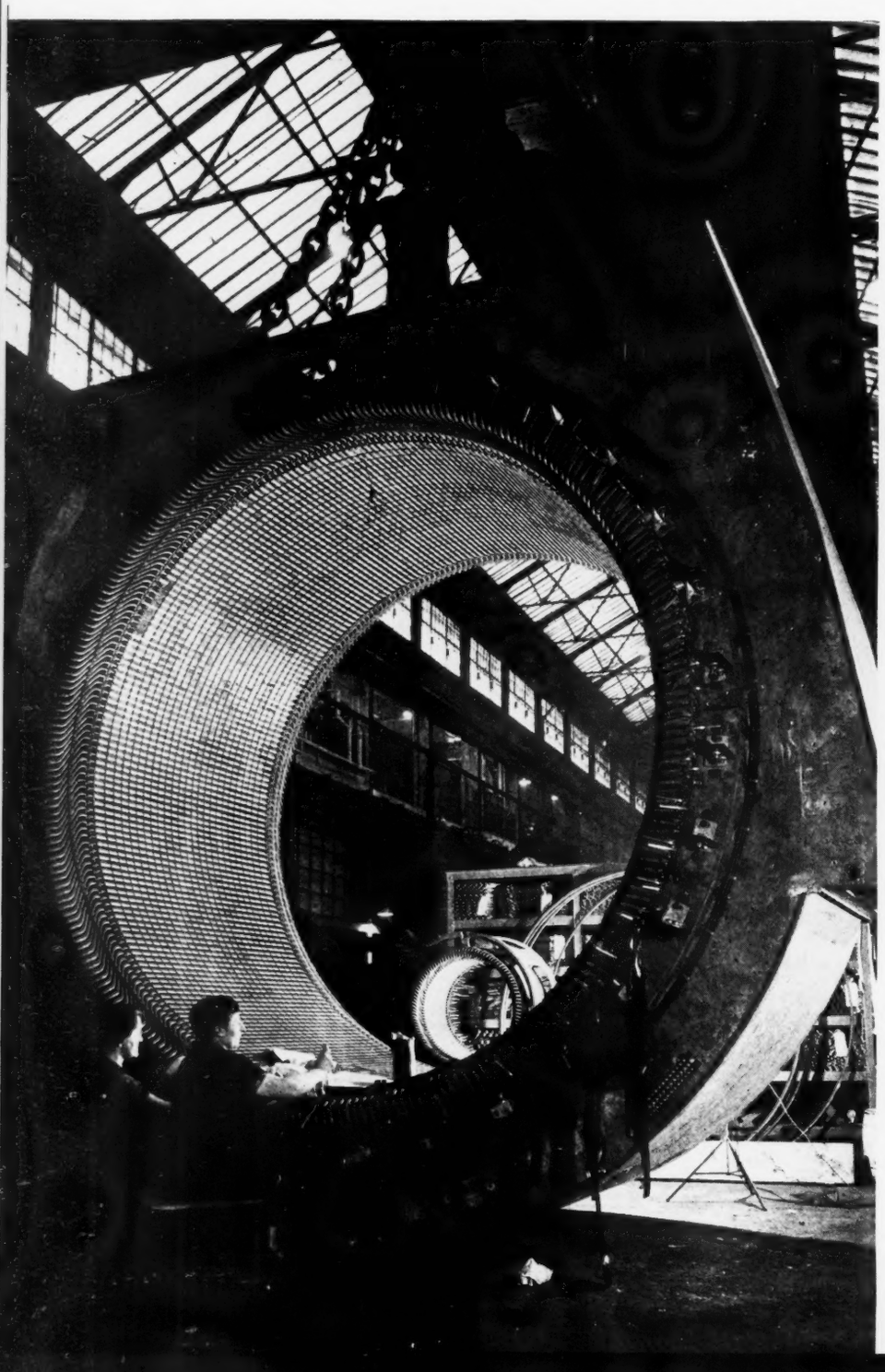
Big-Blow Maker

▶ THE LARGEST WOUND-ROTOR induction motor ever built, weighing 125 tons and standing about 15 ft high, will soon go into service at Wright Field, Dayton, Ohio, to generate a 400-mile-per-hr hurricane.

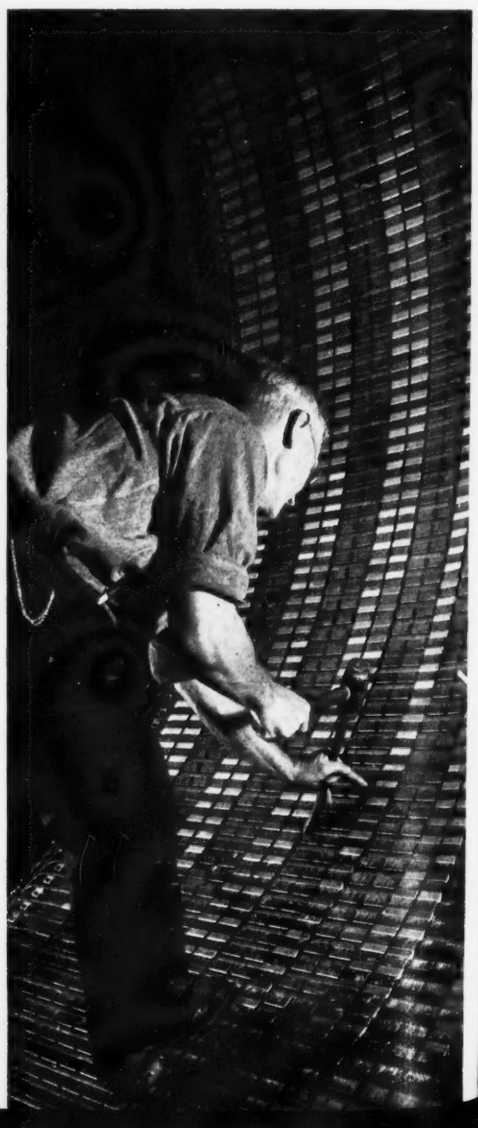
The combination of this 40,000-hp motor-driven fan and 616-ft wind tunnel is designed to test full-size plane propeller and engine enclosures, as well as to create actual flying conditions for models of new military aircraft. The new air velocity will be about four times as great as the air speed now used to test models at Wright Field.

When operating at top speed, the motor will consume more than 30,000 kw and will transmit its 40,000 hp through a 16-in. diameter steel shaft. In conventional applications of this motor type, speed would be regulated by rheostats and a series of resistances, through which excess power would be used up as heat when the motor was operating at reduced speeds. Air Corps engineers have eliminated much of this waste of electrical energy and obtained a speed range of 37 to 297 rpm by a system of two motor-generator sets, also built by Westinghouse.

Hurricane velocities will be created by this 40,000-hp fan motor, built by Westinghouse Electric & Mfg Co for the Wright Field aeronautical wind tunnel near Dayton Ohio. Women are here shown putting finishing touches on windings of the stator. The frame of a conventional 350-hp motor in the background is dwarfed by the frame of this power giant



Skilled hand work was required in manufacturing the largest wound-rotor induction motor ever built, which will create wind speeds of 400 miles per hr to test airplane models in the new aeronautical wind tunnel at Wright Field. Here a Westinghouse craftsman is fitting some of the windings into the stator



Longer Life from Conveyor Belts

Paul W Van Orden, Product Sales Manager, Belt Department, B F Goodrich Co, shows how to get long life and trouble-free low-cost service from rubber belts on conveyors

▶ ON A BELT CONVEYOR SYSTEM, the belt is not only the most expensive part of the installation but it is also subjected to the most wear and tear, even under the best conditions. The belt is also the part most likely to be abused in operation. These facts emphasize the importance of maintaining conveyors properly. Whether a conveyor belt, costing several thousand dollars, gives 2 or 10 years service is very largely a matter of the kind of care the equipment gets.

All conveyor belts handling stone, coal, sand and similar materials are made of cotton fabric and rubber, of which there are several constructions. No matter what fabric and rubber combination is used, the fabric supplies all the structural strength and does all the work of supporting and pulling the load. The rubber with which the fabric is impregnated and covered supplies no structural strength, but takes all the abrasive wear, impact and corrosive action of the material being handled and protects the fabric from damage.

Resisting Abrasion

Resistance of cotton fabric to abrasion, moisture and corrosive effects of acid solutions is practically nil. Therefore, it is imperative that the rubber cover of a conveyor belt be maintained unbroken at all times to prevent premature failure. Rubber will resist abrasion and wear better than steel but it must not be stressed beyond its elastic limit, such as may occur when heavy sharp lumps drop several feet against its surface, or it will fail. This is particularly likely to happen if the section of the belt hit is resting on a roller as in Fig. 1, for the belt is then subjected to a hammer and anvil action.

Conditions under which conveyor belts operate make them more susceptible to abuse in service than most any other type of equipment. Therefore, if proper attention is not given at the time the system is designed to protecting the belt in operation, then no amount of maintenance will achieve long life except correcting the abusive conditions.

The loading chute is the place where a conveyor belt is subjected to greatest wear. A loading chute should be designed so that the material will be delivered to the belt in the same direction of travel and speed. This means lowest slippage between material and belt.

Fig. 1—In this installation the discharge from the crusher falls on the belt directly over the tail pulley and subjects the belt to severe pounding and abrasion

Many factors, such as kind of material, angle at which the conveyor operates, etc, prevent complete elimination of slippage where the material comes onto the belt. Much can be done in the design of the equipment to keep this slippage at a low value and thus greatly increase belt life.

The loading chute should be directly over the belt and parallel with it, see Fig. 2. Loading at an angle from the side of the belt not only increases abrasive wear on the rubber cover, but may cause the belt to climb the idlers and damage its edge. Where it is necessary to load the conveyor from the side, the lower end of the chute should be turned so that the load comes onto the belt parallel with its travel.

When handling heavy material with fines, install a screen in the lower end of the loading chute. The screen allows

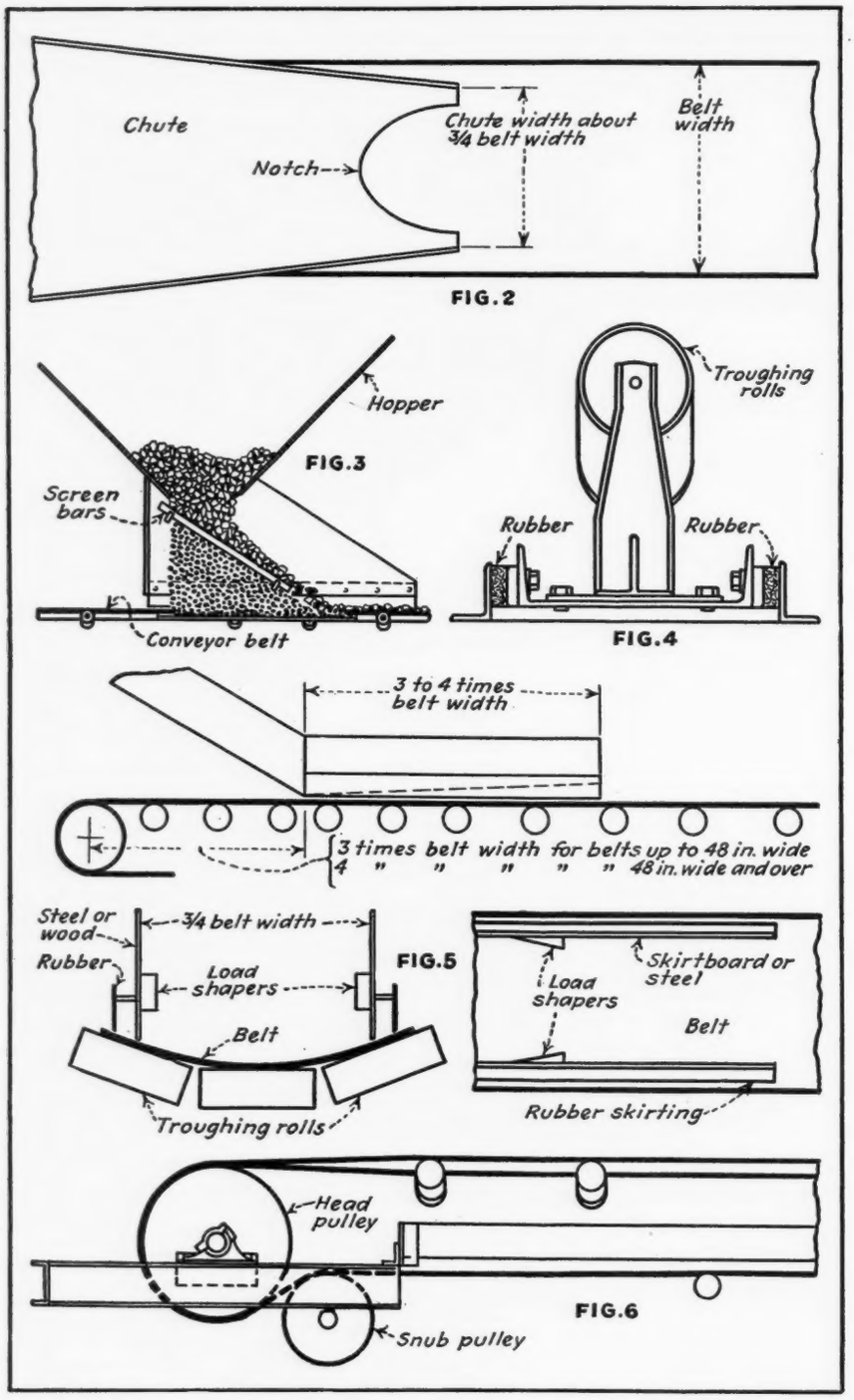


Fig. 2—The loading chute should be parallel to the belt wherever possible. Fig. 3—A screen in the lower end of the loading chute allows the fines to flow onto the belt first, thus protecting it against impact of the lumps. Fig. 4—Conveyor idler supported in rubber mountings absorbs part of the loading shock. Fig. 5—Skirt boards should be placed along the belt at the discharge end of loading chute. Fig. 6—A snub pulley, which increases belt wrap around head pulley, achieves same results as lagging

the fines to flow through onto the belt to form a cushion for the coarse material and lumps as they come off the end of the chute, as in Fig. 3. When this method of loading is used, watch the screen as it may clog and defeat its purpose.

Cutting back the end of the chute at its center (Fig. 2) has been used to accomplish the same purpose as a screen. As the material moves down the chute, the fines tend to work to the bottom of the stream and fall onto the belt before the coarser lumps.

Where space limitations prevent bringing the discharge end of the chute down near the belt, or if the chute must be made so steep that the lumps approach the belt at fairly high velocity, installation of some form of a baffle to reduce the velocity of the lumps will pay handsome dividends in increased belt life.

Fig. 7 shows a bar baffle that has been successfully used to prevent the material from falling heavily onto the belt. The iron bars are suspended from their top ends to swing free at their bottom ends. A cable threaded through holes near the top ends of the bars increases their resistance to shock of the lumps and prevents a bar that might be torn loose from falling onto the belt and being carried away with the material. Hardwood logs have also been used in a similar manner as swinging baffles. Material striking the baffles loses its velocity and slides easily onto the belt.

Watch Part Loading

With whatever means is used to ease the material onto the belt, care must be taken not to slow it up too much because the belt will not be fully loaded, or the chute may clog. A partly loaded belt wears in the center loaded section only. When this happens, carrying capacity of the conveyor is reduced without any decrease in belt wear.

A conveyor that cannot be kept properly loaded at a given speed should be slowed down. Then the entire working surface of the belt will be utilized and its life increased, since it will pass under the load chute less frequently to handle a given tonnage.

Skirt-boards are usually necessary immediately in front of the loading chute to insure good load formation and to prevent spillage. They should extend along the conveyor far enough to permit the load to come to rest before reaching the ends of the skirt boards. Three

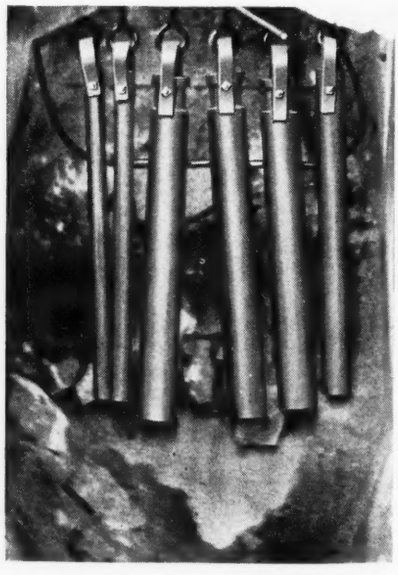


Fig. 7—Free-swinging bar baffles in the loading chute absorb the shock of the material and ease it onto the belt

to four times the belt width is usually a satisfactory length for these boards.

Fig. 5 shows a design of skirt-board that has been used successfully in forming a maximum load of run-of-mine coal on a 48-in. belt. The boards are set in about 6 in. from and parallel to the edges of the belt. Space between their lower edges and the belt gradually increases away from the loading point. At their rear ends the boards just clear the belt; at the front they clear by about 4 in. This taper prevents small lumps catching between skirt-boards and belt.

Any coal working between the skirt-boards and belt is guided onto the belt by a rubber strip supported out about 4 in. from the boards. Shapers inside the skirt-boards guide the lumps toward the middle of the belt; their most effective position can be determined by experiment. All skirt-boards should be carefully watched to see that they do not get out of adjustment or come in contact with the belt surface, or they may cause excessive wear on the belt.

Belt Idlers

Belt idlers are next in importance to the loading chute on the life of the belt. The troughing idlers under the loading chute should be spaced more closely than along the normal run of the conveyor. Place them so that the load comes onto the belt between two rolls, to cushion the impact and reduce abrasion. These idlers may be provided with rubber mountings, Fig. 4, to absorb part of the loading shocks.

Along the normal run of the conveyor spacing of the troughing idlers depends upon the tension in the belt, weight of the material handled, width of belt and inclination of the conveyor. Tension in the carrying side of the belt varies from a maximum at the head pulley to a minimum at the tail pulley. On some conveyor systems advantage is taken of this and spacing of the troughing idlers is varied from the head to the tail end. For example, if a 4-ft spacing of the idlers is required at the head pulley, the spacing may have to be decreased to 2 ft near the tail pulley.

On most conveyors the troughing idlers are uniformly spaced. A good spacing rule-of-thumb for conveyors handling coal is 3½ ft for belts 48 in. wide and 5 ft for 14-in. belts. If idlers are too far apart, the load tends to flatten out the belt between them, which tends to subject the belt to excessive bending. This action causes the load to shift continually on the belt as it runs over the troughing rolls and reduces the life of the belt by abrasion. Too few troughing rolls also increase the power required to drive the conveyor. Tests made on one conveyor showed that removing every other troughing roll increased power consumption 20%.

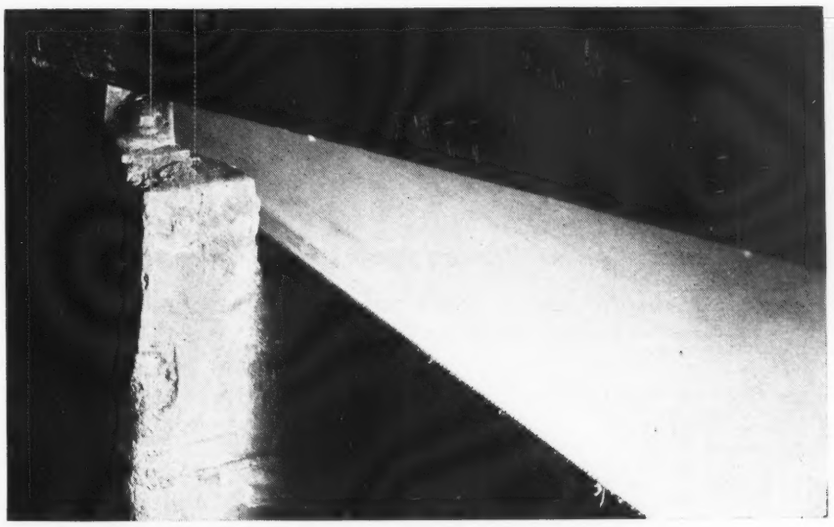


Fig. 8—Crooked running caused belt to rub against concrete abutment and wear off rubber covering from edge of belt

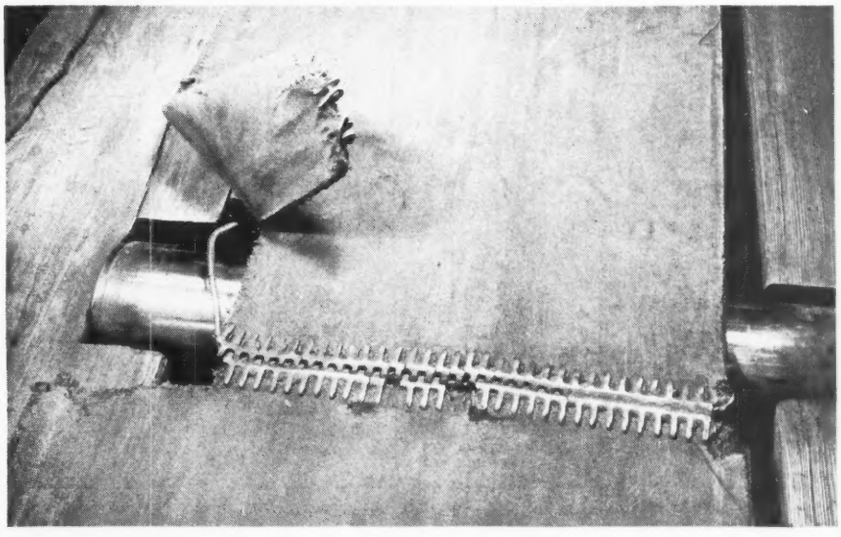


Fig. 9—This belt was seriously damaged by rubbing against an obstruction which first broke loose the belt hooks, then ripped the fabric

Care should be taken to protect the return strand of the belt against lumps falling on it and being carried around the tail pulley. Belts have been seriously damaged in this way. Moist material tends to cake on the pulleys to form an uneven surface that distorts the belt and reduces its life. A complete decking over the return strand of the belt is the best protection against trapped lumps between belt and pulley. Various types of brushes are available for cleaning the surface of the belt, but they must be watched because they wear and become ineffective.

Faulty idlers are another common source of conveyor-belt abuse. Dirt accumulations on idlers subject the belt to bending stresses and abrasion. The latter is caused by movement of the belt under its load. Watch the idlers to see that they run freely. Idlers have been known to freeze to their bearings because of insufficient lubrication or other causes. Cases are on record where idler rollers remained stationary so long that the belt wore completely through the idler rims by sliding over them. Needless to say, the belt was also seriously worn and damaged.

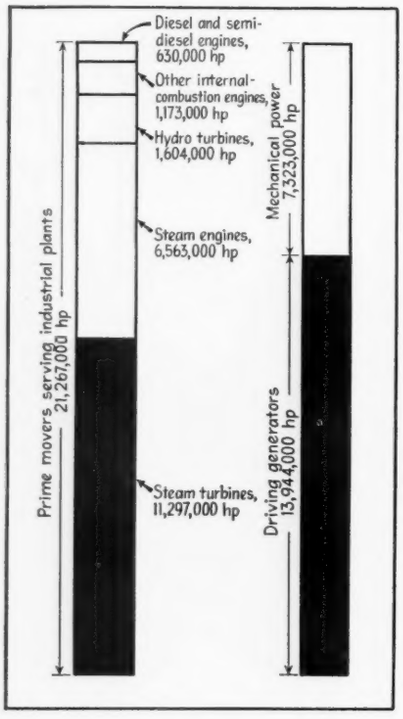
On regular inspections of the conveyor watch to see that all idlers run freely. Listen for squeaking idlers—danger signals of insufficient lubrication that may soon lead to trouble. Lubricate the idlers properly but do not over lubricate them because grease or oil is very destructive to rubber. Excessive grease pressure forces out grease seals in ends of bearings and permits entrance of dirt to increase friction and ruin the bearings.

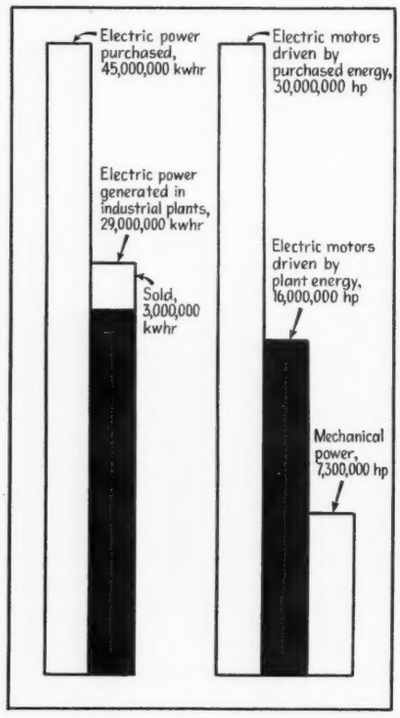
Watch for misplaced idlers. Remova-

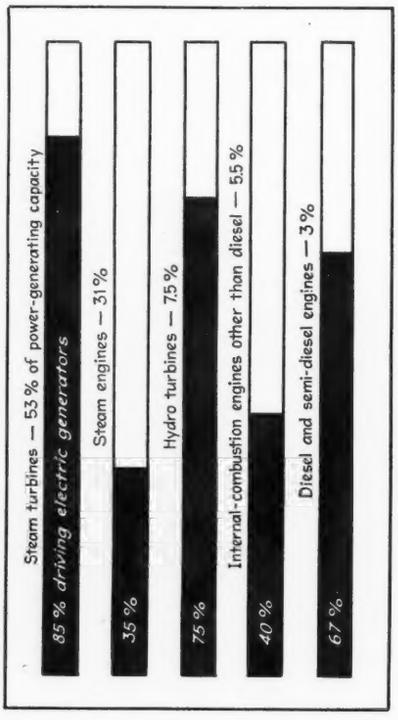
(*Continued on page* 134)

51 Million Hp Turns Industry's Wheels

Preliminary Census Bureau report shows majority of industrial plant power generation is by steam turbines. Purchased current drives large part of electric-motor capacity


Diesel and semi-diesel engines, 630,000 hp
Other internal-combustion engines, 1,173,000 hp
Hydro turbines, 1,604,000 hp
Steam engines, 6,563,000 hp
Steam turbines, 11,297,000 hp
Prime movers serving industrial plants 21,267,000 hp
Mechanical power 7,323,000 hp
Driving generators 13,944,000 hp


Electric power purchased, 45,000,000 kwhr
Electric power generated in industrial plants, 29,000,000 kwhr
Sold, 3,000,000 kwhr
Electric motors driven by purchased energy, 30,000,000 hp
Electric motors driven by plant energy, 16,000,000 hp
Mechanical power, 7,300,000 hp


Steam turbines — 53% of power-generating capacity
85 % driving electric generators
Steam engines — 31%
35 %
Hydro turbines — 75%
75 %
Internal-combustion engines other than diesel — 5.5%
40 %
Diesel and semi-diesel engines — 3%
67 %

Horsepower of electric motors, an index of industrial production capacity, has increased more than 10 million hp since 1929, according to a report recently released by the Bureau of the Census giving 1939 information. A total of 46 million hp in motors and approximately 7 million hp in mechanical-drive prime movers is connected to the production machinery. For the 16 million hp of motors supplied from plant-generated energy, 10 million kw or about 13 million hp, are available in industrial power plants.

More than half this total driving machinery is supplied by purchased energy, 30% by generators within the plant and 14% coming from one or another type of mechanical-drive prime mover. About 45 million kwhr were purchased in 1939 by industrial plants and 29 million kwhr were generated within the plants themselves. Of the latter, nearly 3 million kwhr were sold for use outside the industrial establishments.

Prime movers in industrial plants total over 21 million hp, of which 53% is steam turbines, 31% steam engines, 7.5% hydro turbines or water wheels, 3% Diesel and semi-Diesel engines and 5.5% internal-combustion engines other than Diesel. About two-thirds of the prime-mover capacity drives generators, the remaining third being utilized as mechanical power in one manner or another. Steam turbines number 12,600, steam engines 42,500. Over 5000 Diesel and semi-Diesel engines drive industrial equipment and 10,300 other internal-combustion engines are in service. Water wheels and hydro turbines total 3900.

A new tabulation, not heretofore available, indicates that close to two million hp of prime movers, included in the figures above, is ordinarily idle either as standby or otherwise not normally utilized. This figure, reported as at the end of 1939, is probably far from representative of present conditions, when every power-producing unit is in demand.

Proportion of generator capacity to prime-mover capacity for each type of prime mover is reported for the first time. Of steam-turbine capacity, 85% drives generators while for steam engines the proportion is only 31%. Hydro-turbine and water-wheel power is 75% converted to electric power but Diesel and semi-Diesel engine drives are only 67% connected to generators; other internal-combustion engines only 40%.

Present preliminary reports concern only electric power by industries and industry groups. Further statements will cover power in each state and for several large industrial areas. Other information will follow concerning utilization of fuels by industries and by states. These will give some indication of steam use for purposes other than power generation for which a large part of industrial fuel is consumed. As no boiler capacity and output figures will be available, fuel consumption will be the measure of steam generation.

THE OPERATING ENGINEER

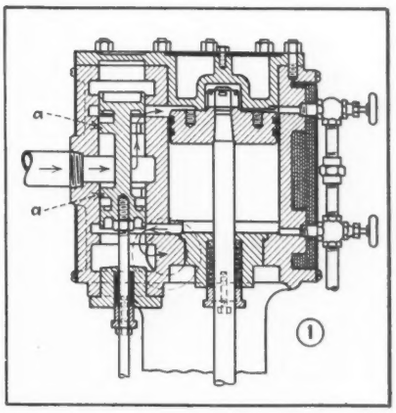
George Edwards
Advisory Editor

Practical Aids
Maintenance Hints
Questions — Answers

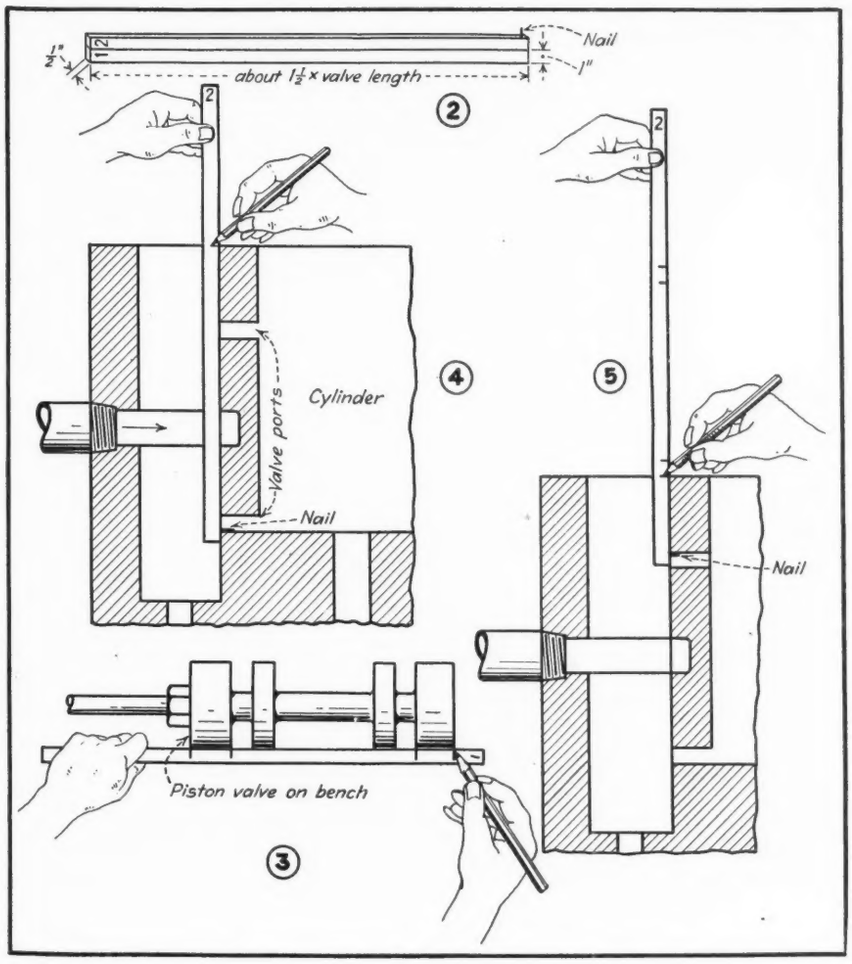
Published monthly as an integral part of POWER

How to Set Piston Valves

S M Elonka[1] gives a step-by-step description of a simple and accurate method of setting piston valves, using easily made measuring sticks



FOR A NUMBER of reasons, operating engineers should check piston valve settings regularly. Wear of valve gear parts such as the eccentric strap, crosshead knuckle and pin, and main crankshaft bearings which support the valve gear, change the setting. Total thickness of shims removed from these parts indicates the actual change in valve setting. Perhaps the most important reason for knowing how to set piston valves is that stems are removed occasionally to turn down shoulders or to install new stems.



Too often the engineer relies on the old marks or makes his own marks, assuming the valve to be properly set. These markings are unreliable and should never be used when it takes so little time to set a piston valve properly. This article passes along to operating engineers and maintenance men a simple and accurate method of setting piston valves which I have found practical in 16 years of building, repairing and operating engines.

Fig. 1 shows the steam end of a single-cylinder engine with a cast-iron balanced-piston valve accurately ground to fit the valve chest. Steam enters on the inside of the valve and exhausts at the ends. This type of valve confuses some engineers because of the two inside rings *a-a*. Careful study of the sketch shows that steam flows through the inside of these rings, which means that they are merely guides and have nothing to do with admitting steam or discharging exhaust. They can be disregarded in setting this type of valve.

First step in valve setting consists of

[1] Now Instructor in Marine Engineering, Metropolitan Vocational High School, New York, N. Y.

making a set of measuring sticks of the general dimensions suggested in Fig. 2. Mark one stick *1*, representing the valve, and mark the other 2, representing the steam ports. Near the bottom of stick *2* drive a small nail, with the head removed, as shown. Remove the piston valve and set it on the work bench so that stick *1* can be held against it, Fig. 3. Top of valve should be near end of stick *1*. With stick against valve, mark it at valve-face edges with a small knife or a pencil, as shown. Remember throughout these operations that the end of the stick *1* represents the top of the valve.

Place stick *2* in the valve chest so that the nail rests on the bottom of the lower steam port, as illustrated in Fig. 4. Mark stick with knife or pencil along top edge of cylinder block, using this edge as a guide. Repeat this operation until all port dimensions are marked on the stick as in Fig. 5. Now draw lines across face of sticks with aid of a small square (Fig. 6) so that markings are at right angles with either side of sticks.

Port widths as marked on the stick will be slightly narrower than true widths because of the nail diameter but this will not affect the proper setting of the valve. In case exact port widths are wanted to determine correct lap and lead, on larger engines for example, the original port markings can be widened by one-half the nail diameter, which will make each port one nail diameter wider.

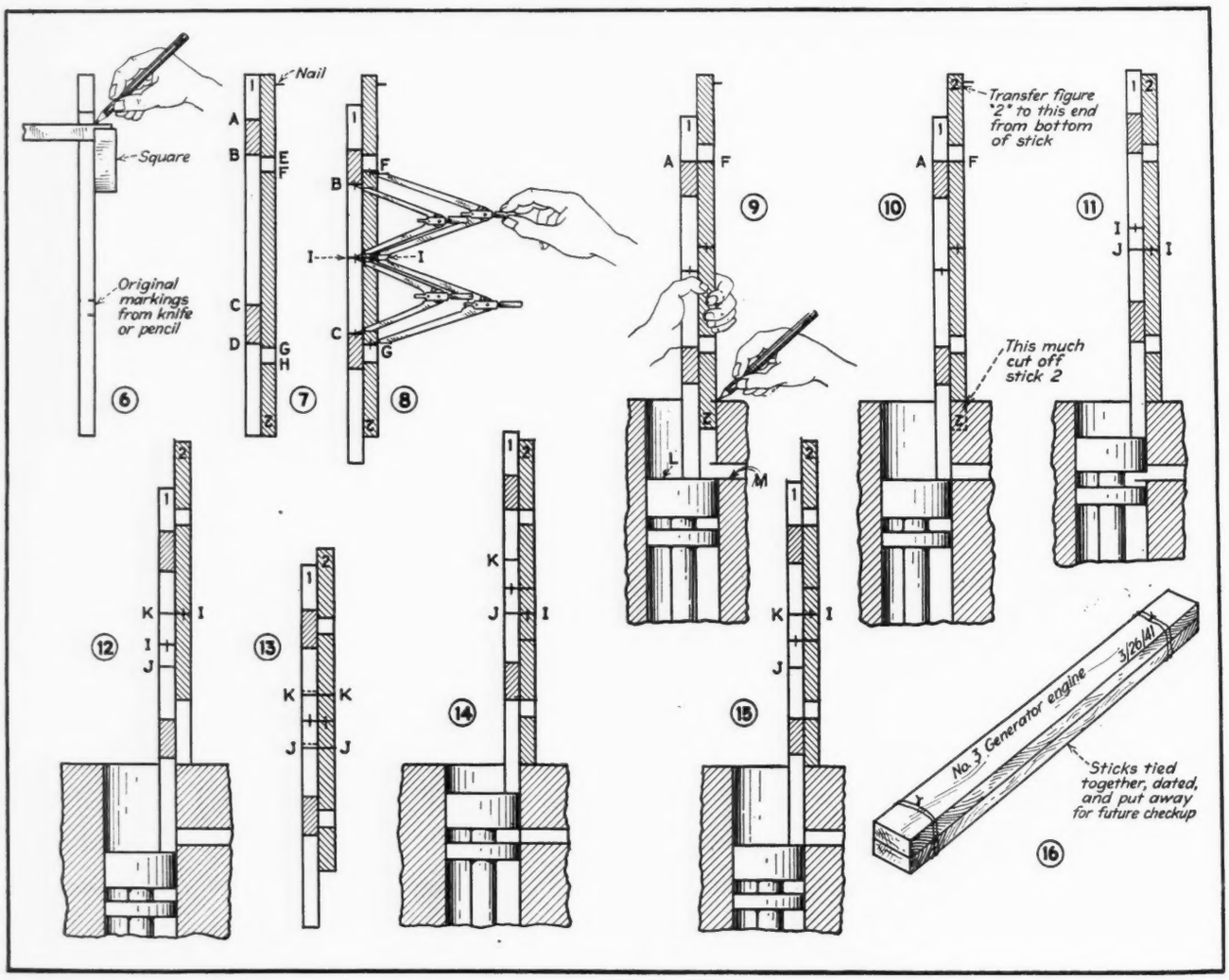
Now turn stick *2* upside down, see Fig. 7. The bottom port was originally marked at the top of the stick and the top port at the bottom. Shade the two sticks with a pencil or crayon or paint black and white to represent valve faces and ports. Since this valve takes steam on the inside, use dividers to find center lines *I-I* (Fig. 8) between inside valve and port edges of *BF* and *CG*. These lines should be drawn with a square and marked as shown so there will be no mistaking them.

With sticks properly laid out to represent valve and ports, and with center lines marked, we are ready to set the valve. During this operation turn the engine flywheel in the direction of normal rotation. If a mark is passed, do not reverse the wheel but make another complete revolution until the mark comes again to the proper place.

Fig. 9 shows that the purpose of the sticks is to transfer the cross section of the valve chest to the top of the engine so that exact position of valves and ports can be seen at all times. Therefore it is necessary to place both engine and sticks in the same fixed position before anything can be done.

To do this, turn the flywheel in the proper direction until the top of valve *L* lines up with the bottom of upper steam port *M*. Now hold sticks together so that lines *AF* on sticks are in line to represent line *LM* in valve chest. It will be seen that the markings on the sticks now represent the exact position of the valve and ports. Keep the sticks in this position and place on the piston valve. Mark stick *2* at top of cylinder block as shown. Cut off stick *2* at this point so that when stick *1* is placed on the valve and stick *2* on the cylinder block, they will register the actual position of valve and ports, as shown in Fig. 10.

Take pains to cut the stick square with the sides. If too much is taken off, cut a little off stick *1* to compensate for it, so that lines *AF* match. The figure



"2" should be transferred to the top of stick *2* to avoid any question about which end of the stick is the top.

With stick *1*, representing the valve, placed on the valve and stick *2*, representing the ports, placed on the cylinder block, as shown in Fig. 11, turn the flywheel until the valve comes to the highest position of the stroke. Mark line *J* on stick *1* opposite center line *I* on stick *2*; line *J* represents top of valve travel. Now turn flywheel until valve comes to lowest point of stroke; mark line *K* opposite center line *I*, as shown in Fig. 12. Obviously distance *KJ* represents the complete valve travel or eccentric throw.

Place sticks on the workbench and transfer, with dividers, distance *KJ* to the back of one of the sticks. Set dividers to exactly half this distance. Put sticks together so centerlines match as in Fig. 13, and lay off and mark lines *KJ* on both sticks at equal distances from centerlines, using the previously set dividers. Old valve travel marks are indicated by dotted lines but they are no longer needed.

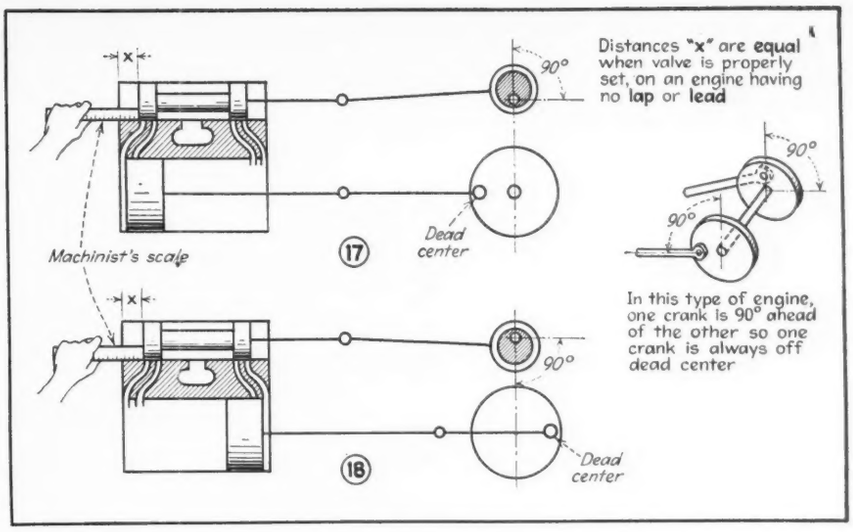
Now place the sticks back on the valve and cylinder block and turn flywheel until valve comes to highest point of travel. Screw up valve stem until line *J* matches centerline *I* as shown in Fig. 14. Turn flywheel until valve reaches lowest point of travel; line *K* should match centerline *I* as illustrated in Fig. 15, if all markings have been correctly placed and the valve has been correctly adjusted.

This procedure gives a setting such that the engine receives the same amount of steam at top of stroke as at bottom, which is perfect for horizontal engines. For vertical engines, adjust the valve so that the bottom port has slightly more opening than the top, to compensate for the added work of lifting weight of piston, rod, crosshead, connecting rod, crank webs and pin. If valve is raised slightly, place marks on stick showing exact amount. Tighten locknut on valve stem and the engine is ready for use.

Tie sticks together (Fig. 16), properly marked and dated, and put them away for future use. These sticks show the amount of lap and lead the valve has, although this information is not necessary for this method of setting valves.

Piston valves in steam winches, hoisting engines, etc, are usually made without lap or lead. It is not necessary to make sticks for setting valves of this type. Just place the crank on dead center as shown in Fig. 17. Remove the valve-chest cover and measure distance from end of valve to edge of cylinder block. Now place crank on opposite dead center, Fig. 18, and measure distance as before. If both distances measure the same, the valve is set properly. If not, adjust until distances are the same.

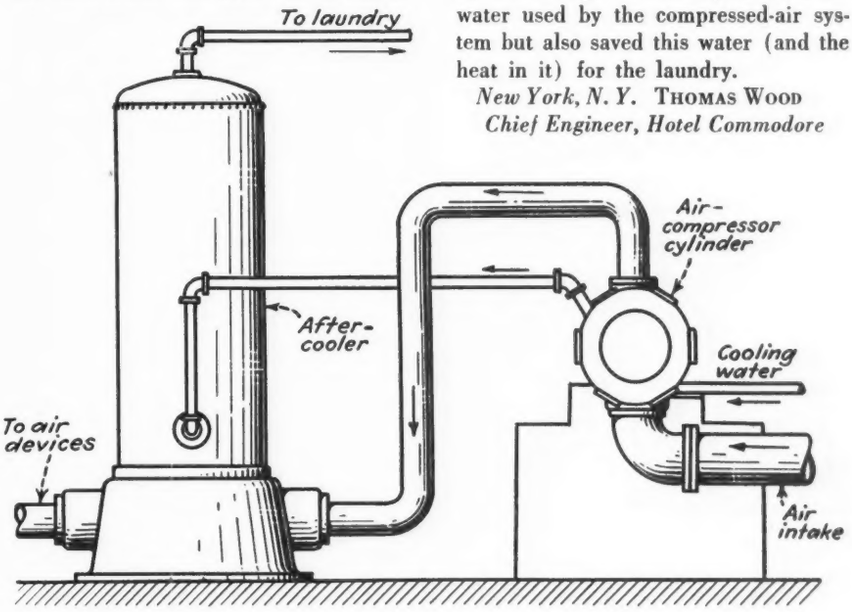
It is simple to set piston valves having no lap or lead because the eccentric is set at 90 deg either leading or following the crank, depending on whether the valve takes steam over the ends or through the center. Therefore, the valve will be in exactly the same position when crank is on either dead center.


Distances "x" are equal when valve is properly set, on an engine having no lap or lead
x
90°
Machinist's scale
Dead center
17
In this type of engine, one crank is 90° ahead of the other so one crank is always off dead center
18

Cooling Water Does Triple Duty

In our plant we have three single-stage, 45-lb, 200-cfm, motor-driven air compressors. These compressors operate in parallel and discharge through an aftercooler. When they were installed their cylinder cooling water was taken from the street mains and after flowing through the cooling jackets went to the sewer. Cooling water for the aftercooler also went to the sewer. This seemed to be a waste of water so we set about to see what could be done about it.

We operate a big laundry that requires a large volume of water and this proved to be the answer to the air-compressor cooling-water problem. We repiped the cooling-water system of the compressors so that the incoming cold water first goes through the compressor-cylinder jackets. Then it passes through the aftercooler and goes into the laundry service-water tank, as in the figure. By this change we not only reduced the water used by the compressed-air system but also saved this water (and the heat in it) for the laundry.



New York, N. Y. Thomas Wood
Chief Engineer, Hotel Commodore

Operating Tips on Open Feedheaters

Open heaters have many advantages–Fred Schubert[1] tells how to make the most of them and avoid troubles

OPERATORS ARE FAMILIAR with the two common types of feedwater heaters: (1) the closed heater in which feedwater runs in tubes with steam in the space outside, and (2) the open heater in which steam and water mix. Each has its place in the plant. The closed heater fits where oily exhaust steam must be kept separate from feedwater or where it is desired to heat feedwater to high temperatures.

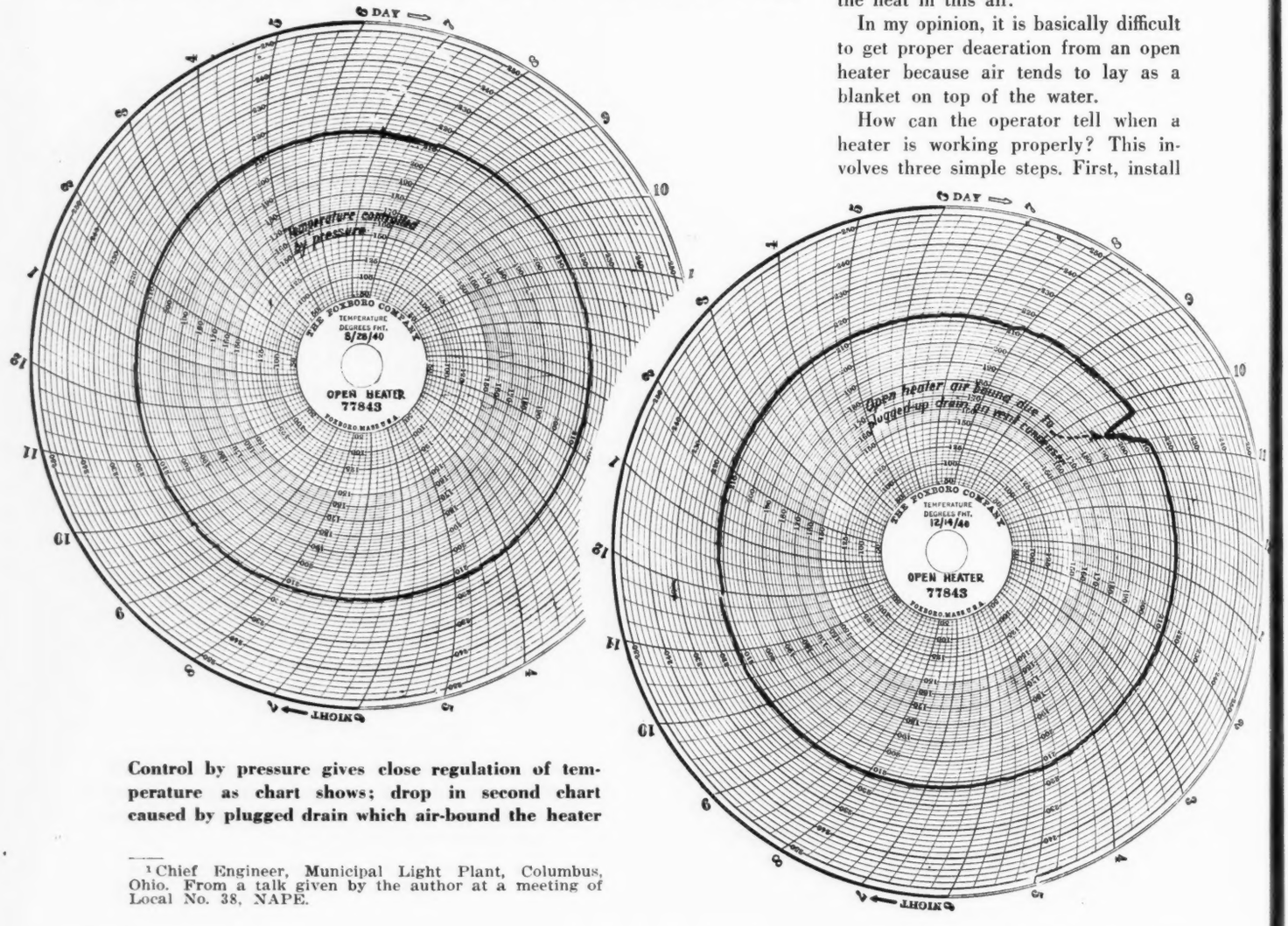
So called "open" heaters usually operate at from 1 to 5 lb gage pressure which thus limits maximum water temperature but these heaters have several definite advantages: (1) because steam and water mix, the feedwater absorbs both latent and sensible heat from the steam, (2) complete deaeration of feedwater can be effected, (3) again because of contact between steam and water, feed can be heated to within 0.5 F of the steam temperature, (4) some purification takes place in an open heater. By use of an oil separator of proper size, properly drained, it is possible to maintain satisfactory feed conditions even when exhaust is oily.

Whether or not a heater produces all these advantages depends on how it is operated. For example, to get proper deaeration, certain basic conditions must be met and the operator must be able to meet them. First condition is temperature. The water must be brought above 212 F and then held 24 hours a day without varying more than 1 F, using live steam through a pressure regulator if necessary to keep temperature up. In this case, best temperature control results from regulating pressure; today the operator can buy a pressure controller to reduce from 200 lb to 0.5 lb in one step, that will hold within one-eighth of a lb.

Deaeration also requires removing oxygen and other non-condensible gases such as CO_2. This means providing for take-off at the surface of the water in the heater. There is nothing to prevent running a 3-in. pipe (perforated for its full length with ½-in. holes) the full length of the heater to a point outside the heater shell. Attach a valve to regulate flow and pressure on the heater. A vent condenser can be added to recover the heat in this air.

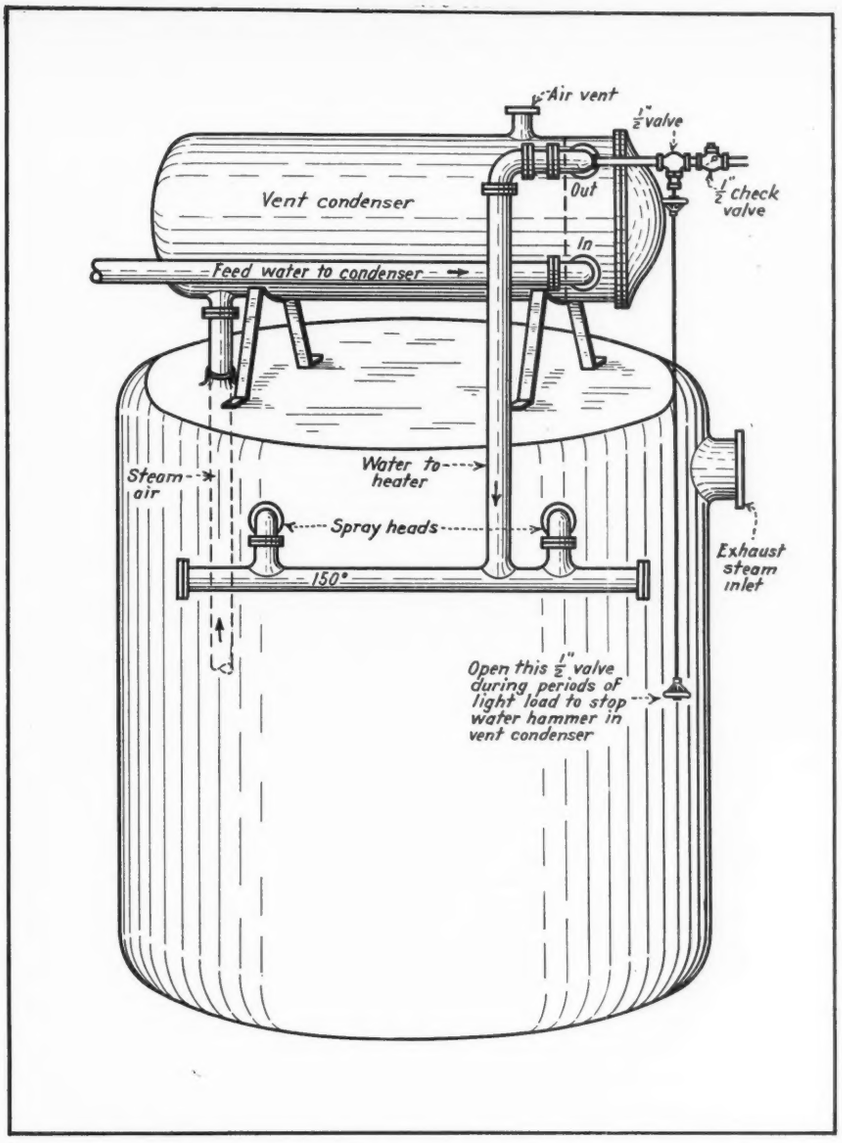
In my opinion, it is basically difficult to get proper deaeration from an open heater because air tends to lay as a blanket on top of the water.

How can the operator tell when a heater is working properly? This involves three simple steps. First, install



Control by pressure gives close regulation of temperature as chart shows; drop in second chart caused by plugged drain which air-bound the heater

[1] Chief Engineer, Municipal Light Plant, Columbus, Ohio. From a talk given by the author at a meeting of Local No. 38, NAPE.



A connection to break the vacuum at top of vent-condenser water space will eliminate water hammer during periods of light load on the heater

two thermometers, one in the steam space well above the water line and one in the water space. These two thermometers should read within half a degree of each other and never less than 213 F. Second, acquire a Winkler oxygen test kit and make analysis of water at the heater to check oxygen content of the feed. Finally, install a 24-hr temperature recorder on each heater. Recorders are very revealing, as the two charts at left show.

One is a perfect chart showing not over one deg variation in temperature; no doubt the water analysis would show zero oxygen throughout the 24 hrs. The other chart shows a bad dip in temperature. At the time the dip occurred, the heater was carrying 1.25 lb pressure, with steam temperature at 216 F. Nevertheless, water temperature dropped to 180 F from air fouling. A flooded vent condenser was the cause.

Analysis of the water showed extremely high oxygen content which, on being pumped into the boiler, tends to cause corrosion and pitting. This is just what an open feedwater heater can help to prevent. In a plant I know, boiler-tube losses ran up to 123 4-in.x20-ft tubes in a year. Proper deaeration improved conditions to a point where five years went by without a single loss. The flooded vent condenser was cured by draining; immediately the temperature rose to 216 F and analysis with the Winkler test kit showed zero oxygen.

Constant temperature is important from another angle. At maximum temperature on a heater carrying one-half lb pressure, the feedwater leaving the heater will run 213 to 214 F and the feed pump will be able to handle this hotwater provided the temperature remains constant. A feed pump will never steam bind, as we call it, on a rising temperature but sure enough will on a slight drop in pressure in the heater. Thus the automatic pressure regulator, using live steam when necessary, is the watchdog on the feedwater system. I have in mind a good-sized power plant, using four centrifugal 4-stage boiler-feed pumps handling feedwater at 214 F. There is only 6 ft from the centerline of the pump to the top of the water in the heater but there is no steam binding, no rattle, and full capacity.

The open feedwater heater will go a long way to help in purification of feedwater, as the trays will prove on inspection. As a suggestion, fill all the trays you can with scrap sheet iron (not cast iron), a ton of it if you can find room. You will get a pleasant surprise at the end of the year when you see how this scrap iron has wasted away. The small amounts of oxygen left in the water after passage through a properly operated open heater will attack any iron it comes in contact with, so it seems sensible to provide the iron in the heater and not wait until the oxygen gets in the boiler.

Oil Separators

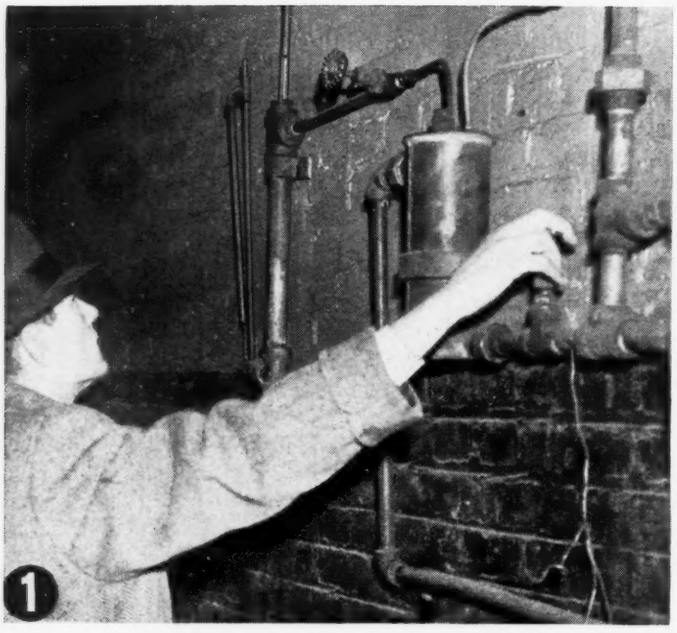
The oil separator gets cussed for all oil-in-boiler troubles but is really not altogether to blame. I have seen several separators that were never given a chance, even when newly installed. The advice to pipe up the separator drain through some form of loop is a bum steer. Oil will not pass but water will, through a conventional loop. Always use an exhaust trap.

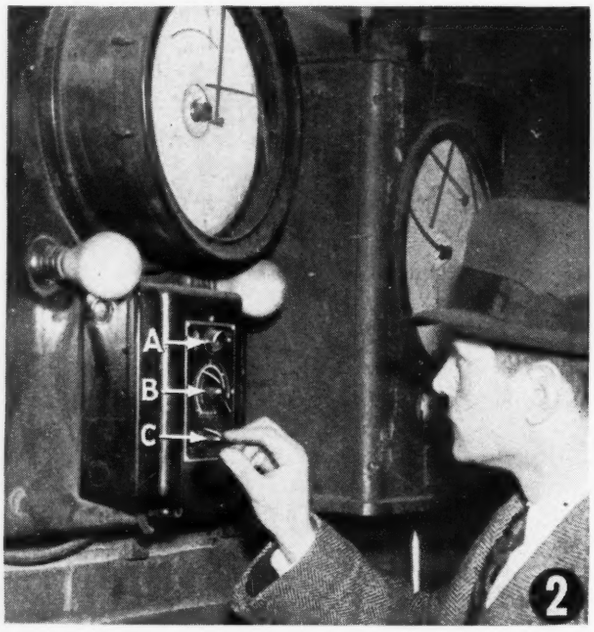
To prove this to your own satisfaction, catch the waste from the loop on the bottom of an oil separator for a week, then replace the loop with a 2-in. pipe leading straight down into a bucket. You will have a big surprise coming to you.

It seems to me that there are unlimited opportunities for improving the little old feedheater. For instance, place a pipe coil in the bottom of the heater, in the water space, and into this pipe all high-pressure trap returns. It will work. Again, if you operate a condensing plant, check the condensate for free oxygen. You will get the surprise of your life to find the hotwell pumps are pumping water plus air, making the heater work overtime to produce oxygen-free water.

The surface condenser is the finest place in the world to produce oxygen-free water—why not take advantage of it? Remember that the surface condenser can deaerate the water, and at the low temperature of 100 F, if we maintain the proper water level in the hotwell at all loads.

PRACTICAL AIDS TO OPERATION





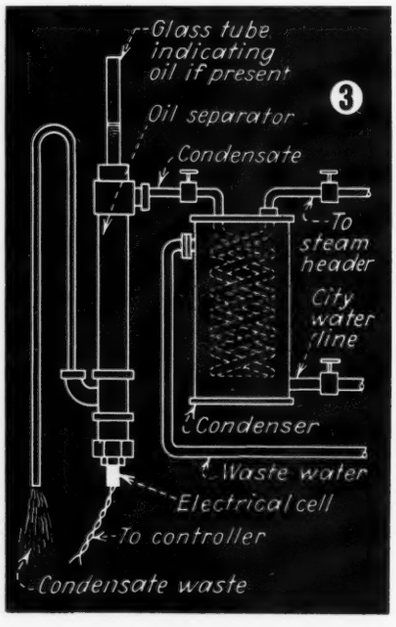
Warning Light Indicates Carryover In Steam

AN INDICATION OF FOAMING BOILERS and carryover of corrosive salts by steam to turbines and other equipment is obtained by a simple warning system installed in the boiler room of a gas plant at Kearny, N. J. By the twist of a knob the boiler attendants can check accurately for the percentage of sodium-chloride carryover in the condensate, and set the warning light for any preselected limit. This warning on carryover in condensate is made possible by an electronic instrument and controller.

A small steam pipe from the boiler header is brought to a home-made condenser, Figs. 1 and 3. City water circulates around the condenser worm. Condensate passes to the top of a vertical pipe 2 ft long, which serves as an oil separator and also takes the electrical cell screwed in at the bottom. The condensate is taken out near the bottom of the vertical pipe through a U-pipe, and visibly discharged to waste, so that flow of condensate can be readily noted. Also, this sight feed into the waste pipe permits taking a sample at any time for chemical analysis.

The electrical cell is wired to the remote controller. Actually, the condenser and associated sampling means are placed in the gallery atop and to the rear of the battery of boilers, while the controller is down near the stokers.

The controller has two knobs *B* and *C*, Fig. 2. One is calibrated in degrees of temperature of the condensate, and is set for a precise reading for control of the condensate carryover. The main knob is then turned. At the same time a magic-eye indicator is observed through the hooded peep-hole *A* at the top of the controller. When the widest angle of dark segment is observed on the magic eye, the knob pointer indicates the percentage of sodium-chloride or carryover in the condensate. This is the analytical function of the instrument. If the knob is left at that reading, the instrument will automatically flash a warning light, ring a gong, or operate a recording instrument. In the case of the Kearny installation, two red lights alongside the controller flash on, while a recording instrument indicates the exact time of the carryover condition and the blowing down of the boiler.



The controller contains a relay which, in turn, opens or closes an external circuit containing the warning signal, so that the boiler can be blown down to dilute the dissolved salts present and relieve dangerous foaming conditions within the boiler. In this installation, the instrument is calibrated in percentage of sodium-chloride and associated salts present in usual city water use.

The Kearny installation has, until now, been largely in the nature of a test. The idea was worked out by the plant engineers. So far, only one boiler is thus checked and controlled, but present plans are to apply the control to the other four boilers. The plant has five 5000-sq-ft boilers, generating steam for the operation of turbines, pumps, gas exhausters, light oil stills, and for a standby electric plant.

Jersey City, N. J. NATHAN SCHNOLL
Chief Engineer
Industrial Instruments, Inc

Shunt-Field Connections Make a Difference

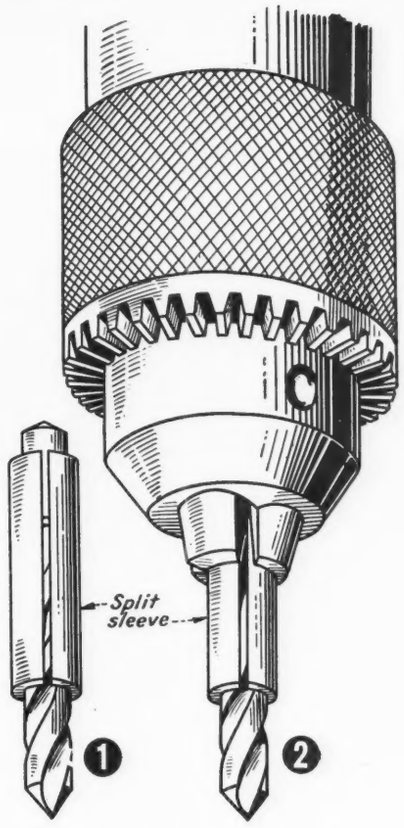
WHAT MECHANICS WITH A LITTLE ELECTRICAL KNOWLEDGE and some with a lot of experience will do with electrical equipment is astounding, as every experienced electrical trouble man knows. In one case, a compound motor and automatic control were installed by the purchaser's mechanics.

A complaint that the motor operated at too high a speed brought a trouble man from the manufacturer, who found that the shunt-field winding circuit had not been connected. This left the motor operating as a series machine, which would race if lightly loaded, took excessive current if fully loaded, heated and sparked at the brushes.

Plainfield, N. J. H W HODGSON

Sleeve Stiffens Small Drills

WE HAD A LOT OF 1/8-IN. HOLES to drill in metal with a portable drill too large for the job; consequently we broke a number of drills. We solved this problem by making a support for the drill, boring a 1/8-in. hole through the center



of a piece of 3/8-in. round cold-rolled steel in a lathe. We then cut through one side of this sleeve with a hacksaw and placed it over the drill, Fig. 1.

This assembly was then clamped in the portable-drill chuck, Fig. 2, with a sufficient length of drill protruding from the sleeve for the hole depth. This scheme solved our problem and since then we have used the sleeve several times on other jobs.

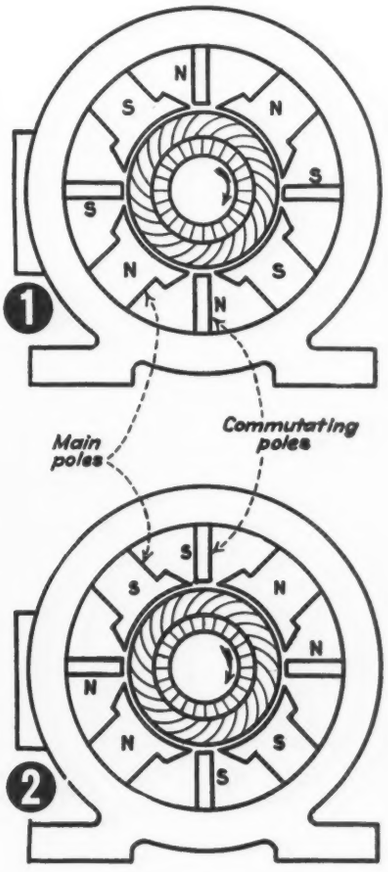
New York, N. Y. S M ELONKA

Correct Polarity of Commutating Poles

WRONG COMMUTATING-POLE POLARITY has often caused serious trouble in generator and motor operation. This was the case with a motor generator set consisting of a commutating-pole, compound-wound, direct-current generator driven by an alternating-current motor, and installed by the purchaser.

When the unit was put into service the generator sparked so badly that it had to be shut down. A service man was called in and found the commutating-pole windings had been so connected that their poles had wrong polarity. Reversing the direction of the current through the commutating-pole windings corrected the trouble.

When connecting commutating-pole machines it should be remembered that in a generator commutating-pole polarity must be the same as the main poles

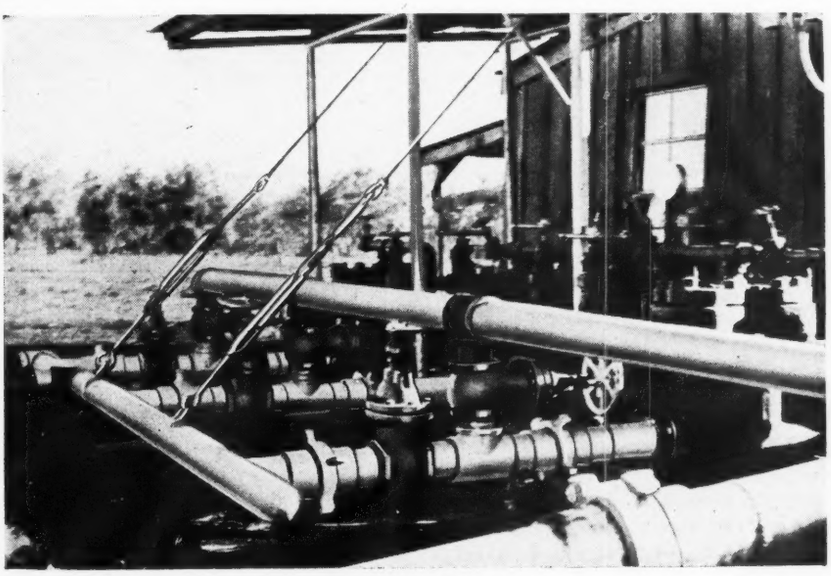


Wire-Rope Guys Cure Vibration

ON A SEMI-PERMANENT PUMPING INSTALLATION consisting of three reciprocating pumps the discharge line connected into a manifold, as in the photo. The manifold and discharge pipes vibrated so badly that some of the lines failed.

To cure this difficulty we welded two loops to the manifold and connected these to the overhead steel-work of the pump-house by wire-rope guys. Turnbuckles in these connections permitted adjusting the tension in the ropes to reduce header vibration to a minimum. This arrangement cured the trouble entirely.

Houston, Texas C C LYNDE

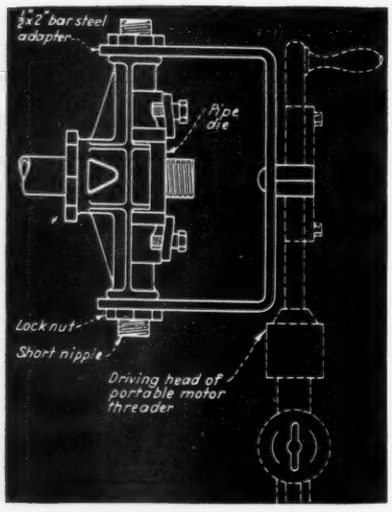


ahead of them, see Fig. 1. In a motor the polarity of the commutating poles must be the same as the main poles, back of them, Fig. 2.

Plainfield, N. J. H W HODGSON

Power Threader Uses Die Stocks

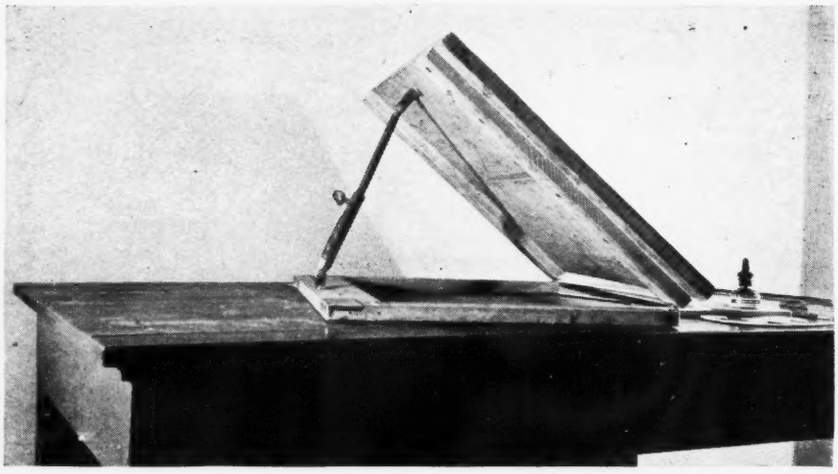
HAND STOCKS USED TO THREAD ⅛- to 2-in. pipe can be readily adapted to a portable power-driven unit, commonly



applied to thread larger-diameter pipes. To do this, remove the handles from the stock and make a ½ x 2-in. steel bracket, as in the figure. Distance between the two ends of the bracket is such that the die holder will fit in snugly.

A short threaded nipple is screwed into each end of the die holder and nuts tightened onto the nipples to hold the die securely in place. A short round-bar connection securely attached to the die holder goes into the power head. We have a unit like this in our plant and it saves a lot of hard work pulling on a die stock.

Atlanta, Ga. H P CLEARY



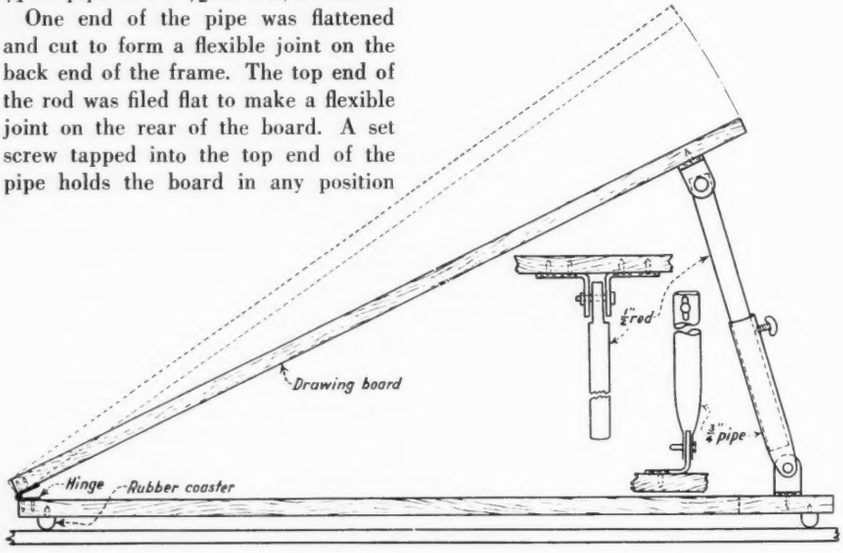
A Comfortable Drawing Board

AMONG MY OTHER DUTIES I serve as draftsman for our plant, but the best equipment I could get was a drawing board on a flat table. The diagram and photo show how I made the board more comfortable to work with. To a frame made of 1x2-in. wood I attached the front end of the drawing board by two hinges. Under the rear end I placed an adjustable leg made from a piece of ¾-in. pipe and a ½-in. rod, as shown.

One end of the pipe was flattened and cut to form a flexible joint on the back end of the frame. The top end of the rod was filed flat to make a flexible joint on the rear of the board. A set screw tapped into the top end of the pipe holds the board in any position after being adjusted. Rubber coasters under each corner of the frame prevent slipping or scratching the top of the table. When the board is not being used the rod can be pulled out of the pipe and the two parts of the support folded into the base. In this way the board can be easily stored in small spaces.

Kearney, Neb.

WILLIAM J KNOLL, JR



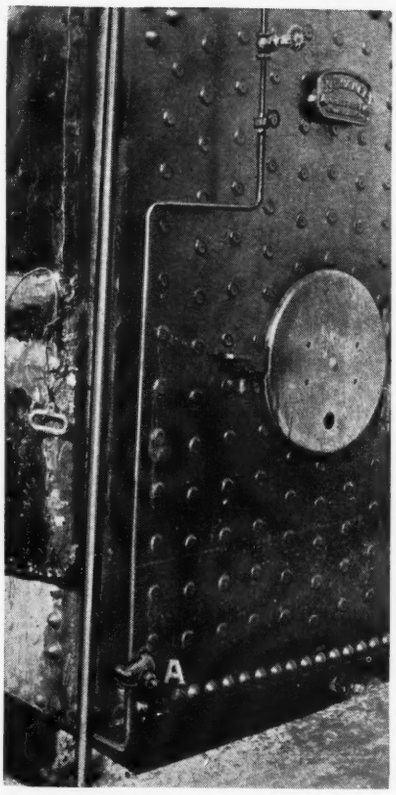
Low Voltage Causes Motor Trouble

A 15-HP, 220-VOLT, 1750-RMP SQUIRREL-CAGE MOTOR direct-connected to a pump gave trouble from overheating. It would start and apparently run all right with the pump discharge valve closed, but when this valve was opened the motor slowed down. Even though the motor had sufficient capacity for the pump it would run hot in a short time and would have burned out in a few hours if left on the line.

All the electrical connections were checked without finding anything wrong. Then a check was made of the mechanical conditions, which showed that the motor bearings were worn. We replaced these and checked the alignment between pump and motor. When the pump was again put into service, the temperature of the motor soon reached a value that would destroy the insulation.

An investigation was then made of the line voltage by connecting two 110-volt lamps in series across the switch. With the motor shut down the lamps burned at apparently normal brilliancy. When the motor was started the lamps burned at a dull glow. A voltmeter connected to the circuit indicated 212 volts with the motor disconnected and only 160 volts when it was running. Low voltage was found to be caused by both the line and transformers being overloaded, a condition which we corrected.

Boston, Mass. B R STEWART



Washout-Plug Clamp Holds Blowdown Pipe

IN OUR PLANT the gage-glass blowdown lines come down the front of the boilers and turn back under them to the blowdown tank. To hold these lines securely on the front of the boilers against the reaction of the water and steam when it turns from vertical to horizontal flow we carried them through the saddle of one of the washout plugs as at *A* in the photo.

When washing out the boiler it is not necessary to take down the pipe because it is sufficiently flexible to be pushed to one side of the washout hole so that the hose nozzle may be inserted.

Houston, Texas C C LINDE

Power Drive Eases Valve Operation

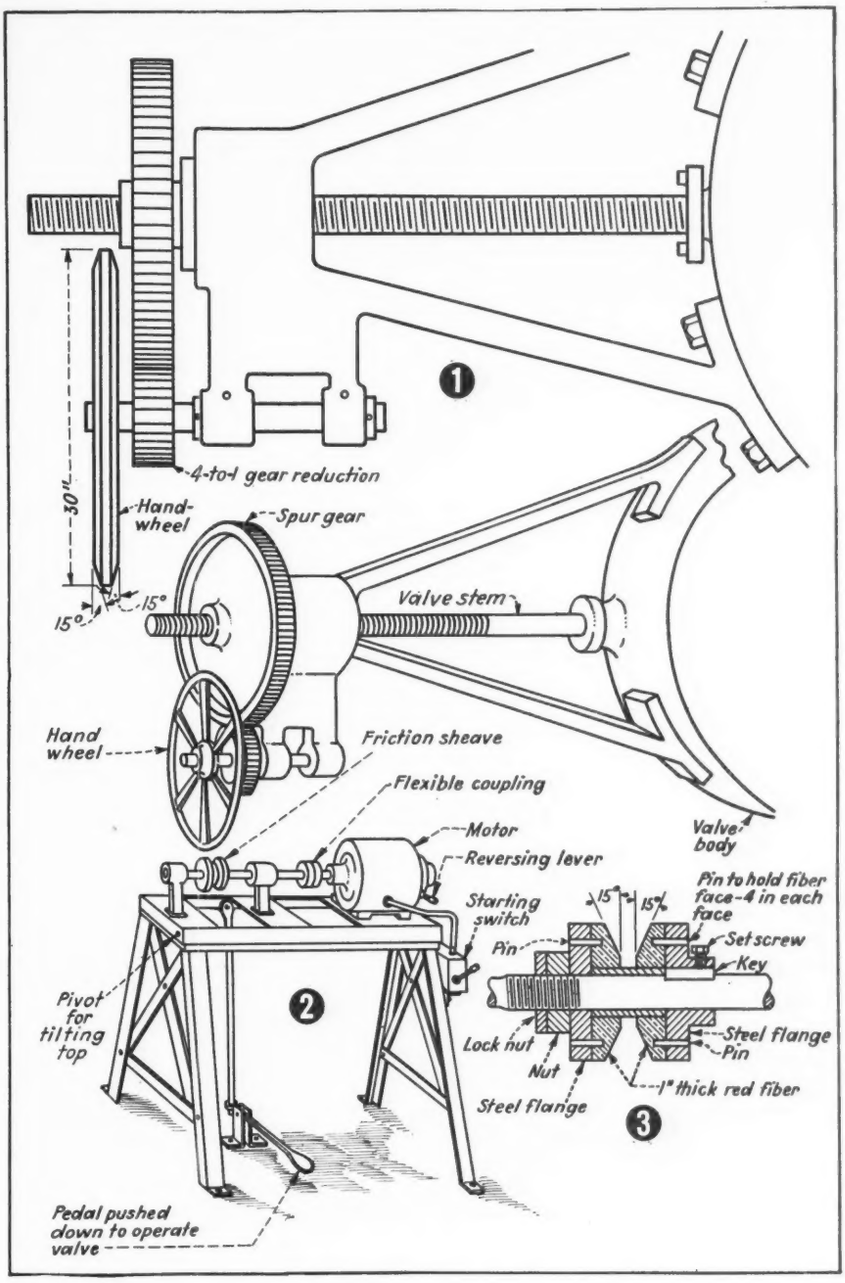
WE HAVE A 48-IN. GATE VALVE in the circulating-water discharge of our condensers. During the summer this valve stands wide open, but in the winter it may be either wide open or partially closed, depending on the amount of recirculation required for proper control of the ice in the water as it comes from the river. This valve was hand-operated through a single-reduction spur gear. To open the valve from closed position was a good half-hour's work for two men. So arduous was the task that often the valve setting was not adjusted as promptly or as frequently as it should have been to obtain the best operation.

To provide easier control of the valve we built the motor drive shown in the drawings. First we removed the handwheel and turned its face in a lathe to a vee shape, Fig. 1. We then mounted a single-phase, ½-hp, 1750-rpm repulsion-induction motor on a stand with a tilting top along with a small fiber-faced friction sheave, Fig. 2. This sheave, a cross-section of which is shown in Fig. 3, is so arranged that it engages the vee face of the handwheel when the motor base is tilted by a foot pedal. The fiber-faced sheave serves both as a speed reducer and a friction clutch, the motor always being started first. The sheave is then brought into engagement by gradually applying pressure to the pedal.

Obviously there is some wear on the fiber sheave, but if it is kept dry and free from oil wear is not excessive. Our installation is finishing its fourth year of service on the original sheave facings, which appear good for several years more. We used 1-in. red vulcanized fiber for the sheave faces.

The motor can be controlled to run in either direction by a lever attached to the brush-supporting ring. This shifts the brushes from one running position to the other. On this type of motor the brush ring is ordinarily held in one running position by a set screw, but for our purpose we left it out and the brushes remain where we put them.

Tecumseh, Kan. H M NAYLOR
Kansas Power & Light Co



READERS' PROBLEMS

Questions from Our Readers

Diesel Generator as Synchronous Condenser?

Question 1

I AM ABOUT TO ASSUME *charge of a power plant where we contemplate installing diesel-engine generating units for peak load. At off times we wish to use the diesel generators for synchronous condensers. Perhaps* POWER *readers can offer some suggestions as to the advisability of this arrangement and the method of hookup*—RFN.

Corrosion in Cooling Coils

Question 2

WE HAVE IN OUR AMMONIA *refrigerating plant several herringbone coils for cooling calcium-chloride brine. An inspection made after leaks developed showed pitting in the electric welds at the point where the pipe-runs entered the headers. These welds were badly pitted and eaten. Acetylene welds in the same tank, and the tank and coils themselves, were in good condition. Attack had been confined to the factory-made arc welds. The coils have been in service about 7 years and pH has always been maintained near 8.0. What is the cause of this corrosion and what can be done to prevent its recurrence?*—WFB.

Crankpin Loose?

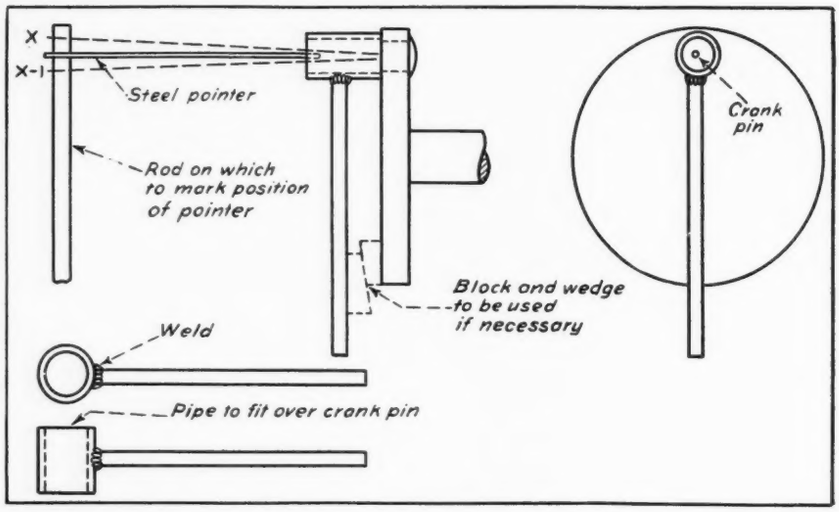
Answers to March Question 1

The Question

WE SUSPECT *that the crankpin on our 28x 42-in., 120-rpm, 825-kva engine-generator is loose. Can some* POWER *reader tell me how to find out if this is the case? The pin has not turned in the disk. The engine is not now in service and steam is not available*—ERG.

Use Lever and Pointer

AS IT APPEARS IMPOSSIBLE to try out the engine under operating conditions, I suggest ERG make the following test. Drill a small hole in the crankpin end, as shown in the sketch, and drive a thin rod into the hole, tightly. The longer the rod the better, provided it is reasonably stiff. Take a piece of steel pipe (or forge a wide ring), and ream the pipe so it fits fairly closely on the crankpin. This piece of pipe should be as long as the pin to avoid any danger of damage. Weld a stiff steel handle on the pipe, about 5 ft long, as shown. Fix a wood or metal rod opposite the end of the pointer rod so the position of the pointer can be marked.



If pushing and pulling at the end of the lever produces any motion of the pin it will appear magnified at the end of the pointer. If no motion can be observed, mechanical pressure, from a jack or other apparatus, may be applied to the lever handle. In general, apply as much pressure as possible, tending to move the pointer toward X-1, then relieve the pressure and mark the position of the pointer. Apply a reasonable pull on the lever, tending to move the pointer toward X, drive a wedge in, as indicated in the sketch, and see if the pointer has moved from the position first marked on the rod. By using a wedge as indicated, assuming that the crank disk has been firmly fixed against rotation, there will be little danger that any observable motion of the pointer has been caused by anything but movement of the crankpin in the disk.

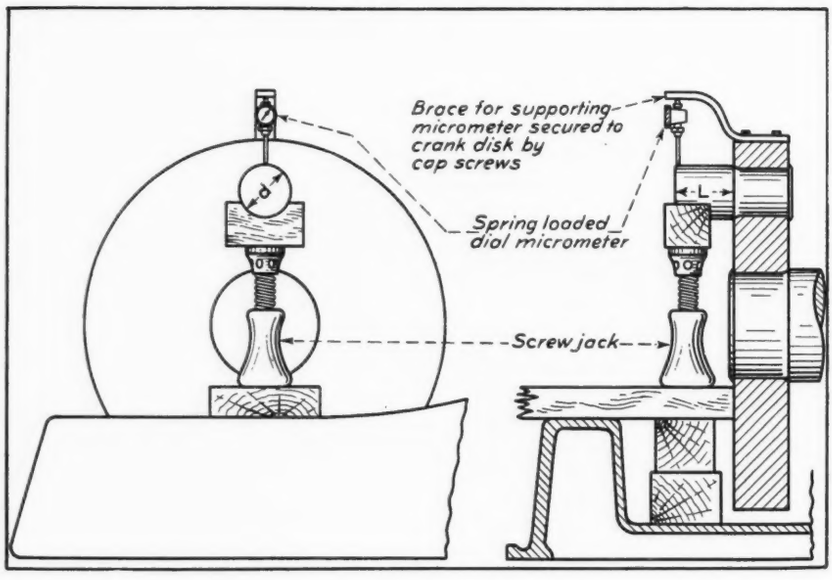
A more sensitive indicator could no doubt be made by fixing a small mirror on the end of the crankpin and reflecting a light beam onto a plane surface located at some distance from the end of the pin.

Bloomfield, N. J. J O G GIBBONS

Spring-Loaded Micrometer Test

FIRST, AS A ROUGH CHECK, strike the pin with a heavy hammer while holding the fingers on the parting line of disk and pin. Any appreciable movement can be detected in this manner. However, considering the size of the engine, it is doubtful if this test would be conclusive. Therefore, I would also make this test:

Rig a spring-loaded micrometer to bear on the end of the pin, as shown in the



sketch, and with a screw jack apply pressure on the pin. In placing the jack, take care to support the jack properly so that excessive force will not be applied to the thin section of the engine frame forming the crankpin. When a moderate amount of pressure is applied to the pin, the dial micrometer will show any movement. If the pin is found to be loose, it should be removed, the opening in the disk bored true and a new pin installed. If the pin is found to be loose a special effort should be made to determine the cause, as this may be the forewarning of more serious trouble.

If the engine has received a severe shock, such as a slug of water in the cylinder, it is possible that the pin or crank disk at the pin is cracked and if so, the pin will be loose in the disk. The crank disk adjacent to the pin should be cleaned and examined with a magnifying glass. If no cracks are found by this method coat the disk with kerosene for an hour and a half, then wipe dry and apply a coating of whitewash (powdered chalk and alcohol mixed to the consistency of milk and applied with a brush or spray gun). After the whitewash has dried, strike the disk several sharp blows with a lead hammer. If the disk is cracked, oil will appear in the whitewash.

If the crankpin is removed it should be examined. Cracks in crankpins usually occur slightly below the surface of the disk or at the point of change in diameter, particularly if a fillet has not been provided at this point. When the new pin is made, attention should be given to providing an adequate fillet at the point where the diameter of the pin is changed. The edge of the crank disk at the hole for the pin should be rounded over so that when the disk is pressed in, the shoulder on the pin will flush with the disk.

Chicago, Ill. A E STEVENSON

Three Methods

FIRST I WOULD REMOVE the connecting rod entirely. Then I would clean carefully around the crankpin and tap the pin with a 2-lb machinist's hammer. A dead sound will indicate a loose pin. Tapping with the hammer and placing the fingers where the disk and crankpin join will show movement by sense of touch. If no apparent looseness is indicated, I would try another method to solve the problem.

Put the connecting rod back in position and key it up extremely snug on the crankpin. Do not connect it to the wristpin. Push the crosshead out of the way. By using the connecting rod as a lever and moving it up or down, any looseness in the crankpin will be evident in the amount the connecting rod can be moved.

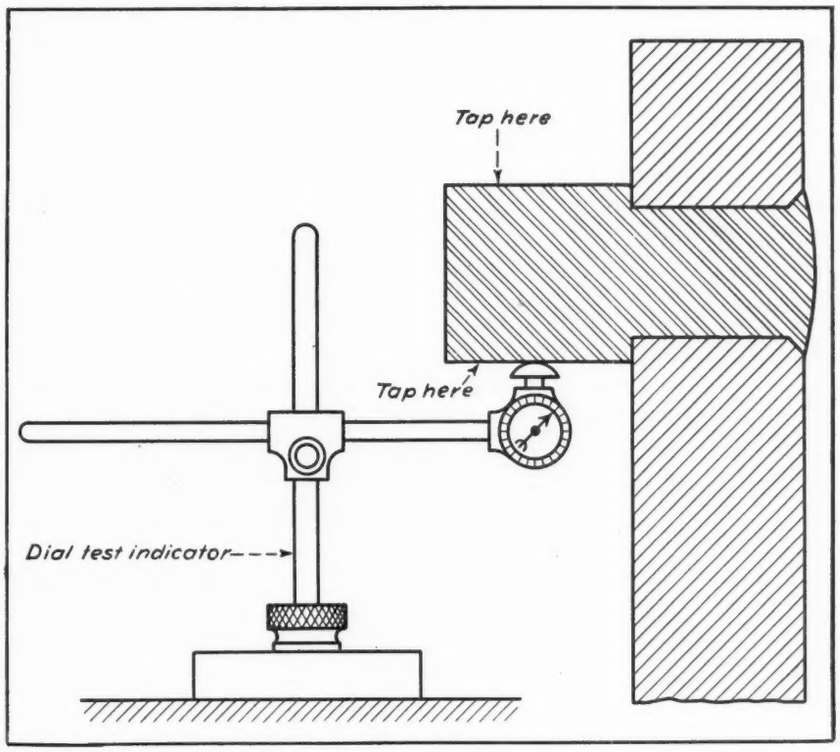
Springfield Gardens, N. Y. R J O'BRIEN

Use Dial Indicator

THE MOST ACCURATE METHOD of checking ERG's crankpin is by means of a dial-test indicator such as is used in the machine shop. Set the indicator on the engine frame or build it up as close as possible to the crankpin. Note the reading on the dial. Tap the crankpin back and forth in the direction of instrument contact, using a heavy hammer and a block of wood to prevent damage to the pin. As the indicator registers in thousandths of an inch, the slightest movement of the crankpin in the disk will register on the indicator. Bar the engine over and test at all angles.

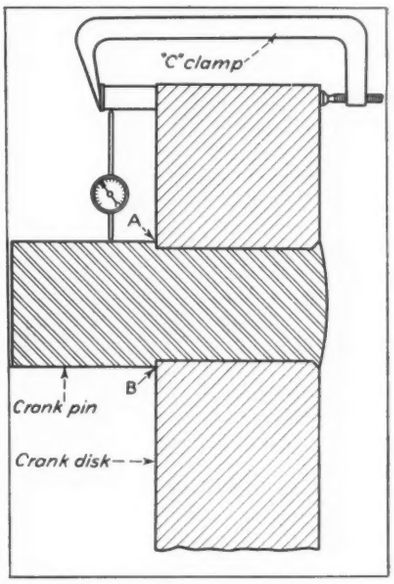
A simpler but less accurate method involves using a set of thickness gages or feelers. Tap the crankpin as before, then insert the thickest feeler that will enter between disk and shoulder of crankpin. Tap the crankpin from the opposite side and again test with feeler. If a smaller feeler can be inserted then the crankpin is undoubtedly loose.

Bronx, N. Y. ANTHONY GREER



Another Way to Use Dial Gage

REFERRING TO THE SKETCH, ERG should bar over the engine until crankpin is at top of travel. He should then disconnect the connecting rod and clamp a steel block



in position on the crank disk. With a dial gage set as shown, place a jack beneath the crank pin and exert upward pressure. Looseness will be registered on the gage. If a dial gage is not available, feeler gages could be used at points A and B, between crank-pin shoulder and disk.

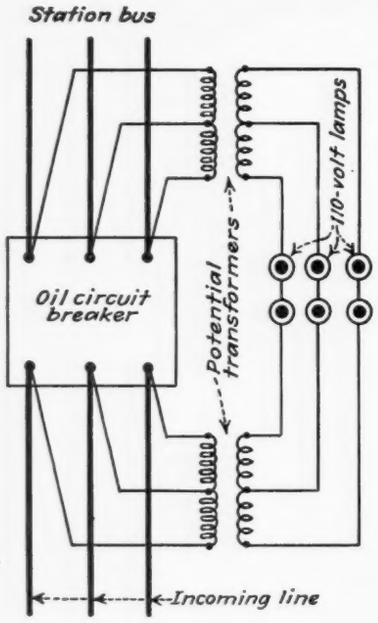
Chicago, Ill. J M TOTTEN

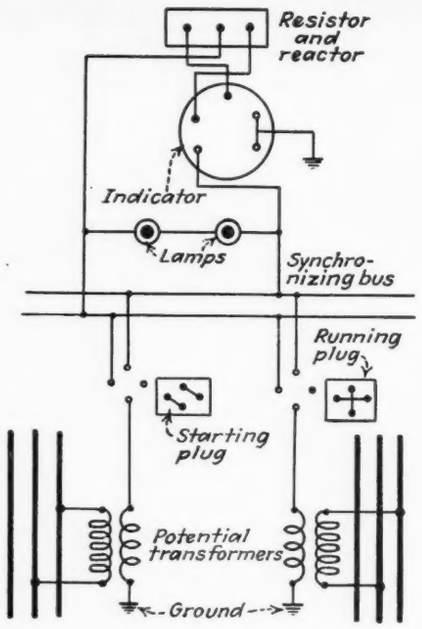
Use Inside Micrometer

ATTACH A ¾ x 2 x 2-IN. ANGLE IRON to the crank disk by means of a "C" clamp. Insert a short micrometer point in one leg of the angle (a No. 5 taper pin will do). Take a reading from this point to the crankpin, using an inside micrometer for the operation.

Set a hydraulic jack under the pin opposite the micrometer point and measure the take-up by means of another micrometer reading. By reversing positions of jack and micrometer point, looseness in the other direction can be measured, giving the total looseness. In my opinion, the maximum looseness would be near the forward and back dead centers. In such an event, there would not likely be a good solid anchorage for the blocking of the jack, so it might be necessary to throw a strongback around the flywheel rim to support blocking on which to rest the jack.

Earp, Calif. J H SCHWEER





How to Synchronize?

Answers to March Question 2

The Question

WE HAVE THREE DIESEL UNITS *generating at 2500 volts, 3 phase, 60 cycle, ac. Each is served by a generator panel mounting load-indicating wattmeter, ac ammeter, dc ammeter, watthour meter, oil circuit breaker, rheostat, dc switch, ac voltmeter receptacle, ac ammeter receptacle, and synchronizing receptacle. We also have one panel for outgoing feeders equipped with an overload protection circuit breaker, watthour meter, and ac ammeter. Our dc panels carry dc ammeters, dc voltmeters, dc switches, rheostats and receptacles. A voltage regulator, synchronism indicator, ac voltmeter, and frequency indicator complete the switchboard.*

We plan to purchase some current from an outside source and would like to know what additional equipment, if any, we need to synchronize our plant with the other source, and how to go about it.—FES.

Needs an Additional Panel

FES WILL NEED AN ADDITIONAL PANEL for his switchboard with the following instruments if he wishes to synchronize with an outside source of power. First, an oil circuit-breaker of sufficient capacity for his conditions, with overload relays and their test blocks connected to current transformers in two legs of the three phase line. This is assuming that the circuit is 3-wire and not 4-wire, otherwise he would need protection in all three phases. He will need an ammeter, which may be in one phase only, or it may be connected to any phase by means of a switch. Better yet, he could have an ammeter in each phase. This depends somewhat on the available finances.

Voltmeter and synchroscope switches should be on this panel and connected to the potential circuit of the incoming line and to the existing voltmeter and synchroscope circuits. A watthour meter will be necessary, although the utility will in all probability install this. At a point near the entrance of the outside power to the building, a disconnecting switch should be installed, and also one as near as practicable to the existing busses, to isolate the circuit-breaker and instrument transformers when necessary to handle them. Wiring of the panel will depend on the existing setup and the particular instruments that might be purchased.

Hanover, N. H. ALVAN L WATERMAN

No Additional Equipment

FES HAS ALL THE EQUIPMENT he needs on his present switchboard except that a power factor meter with plugs on each panel would be handy, but is not necessary. Equip the incoming panel with an oil circuit breaker, ammeters, voltmeter or voltmeter receptacles to connect the incoming voltage to the station voltmeter from a potential transformer on the incoming line, but throw away all but one voltmeter plug. Don't try to read voltage from two sources on the same instrument at the same time. If there is only one plug, it's simple; you can't.

Phase out the incoming line across the open breaker as at left above. If lamps go on and off together you have the current phase sequence, when they alternate, you are wrong and must change two leads to the incoming line. Don't change them at the breakers, or if you do, be sure you leave the potential transformer leads where they were. Don't move them around. When lamps light and go out together, connect up your synchroscope bus as at right above, or exactly as it is on your engine panels. To be sure you are right, after the synchroscope is connected to the same phase disconnect the engines from the station bus and close the incoming switch with the synchronizing plugs in place. If you are right, the synchroscope will show synchronism and the lamps will be dark.

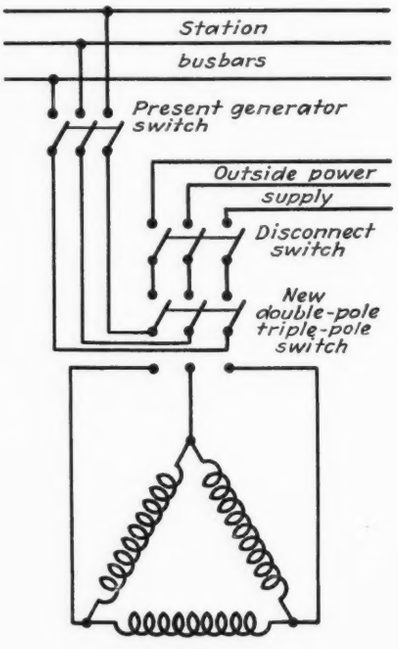
Operation of the incoming panel will be exactly like the engine panels, except to change the load you must change your engine speed and you must take care of the power factor by adjusting the field rheostats. Operate the incoming line exactly as you would an engine that does not have a governor but runs at fixed throttle and voltage. You have three engines so you know what is meant by that.

Carlsbad, N. M. E A ROBERTS

Gives Three Solutions

THE ELECTRICAL CHARACTERISTIC (voltage-phase-cycle) of the diesel alternators must be such, as to permit parallel operation of the diesel generating units with the outside source. In absence of more data, on the rating of diesel alternator, operating sequence of diesel generating units, feeder to main bus and installation expenses, I submit the following suggestions:

The installation of another control panel, including alternating-current instruments, synchronizing receptacle, potential receptacle, extending the synchronizing bus to



this panel with adequate feeder to main bus, would be the ideal solution. An additional panel could be eliminated by installing a double-throw triple-pole switch between a selected diesel alternator and its switch, as in the diagram. This would permit FES to utilize one panel of the present switchboard and to synchronize the other two diesel generating units with the outside source or vice-versa.

Still another alternative would be to install double-throw triple-pole switches between all diesel alternators and their switches, thus with either control panel, parallel operation could be performed.

New York, N. Y. CARL BACHMANN

Provide Lightning Protection

FOR FES TO CONNECT PURCHASED POWER SUPPLY to his present Diesel plant he should install another switchboard panel similar to his present generator panel with an indicating wattmeter, an ammeter, a transfer switch, if current transformers are used, a voltmeter, and synchronizing plugs using the same hook-up as on the Diesel panel. Space should be left at bottom of panel for power companies metering equipment, which may be a plain wattmeter and a recording demand meter or a watthour meter with a demand dial. Provide circuit breakers with interrupting capacity to protect the equipment properly, and if size warrants, install a reverse-current relay to protect Diesel equipment in case of a purchased-power failure, which would cause the Diesels to try to carry the outside system load.

Synchronizing wiring should be checked to get the same phase relation. Some trouble may be experienced with voltage regulators. I believe some experimenting may be needed to get them to work properly or it may be advisable to let the power company do the regulating.

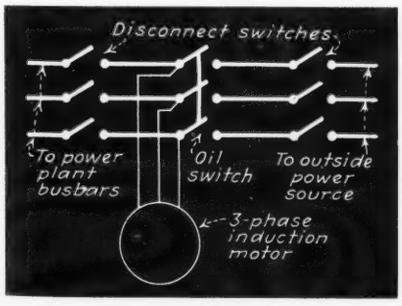
Proper lightning protection should be installed to prevent surges coming in on power lines to damage generators and motors. Some adjustments may be necessary on engine governors to make the generators share the load properly. All the mentioned operations are standard practices and FES should have no difficulty in getting the combination power supply to work satisfactorily.

Hudson, Mass. G D NOILES

Check Phase Rotation

IF FES CONTEMPLATES hooking up with a public utility system, he had better consult the company. The company may not permit operating a private plant in parallel with its system. Whether it does or does not, it will tell him just what he will have to install and how to go about doing the job.

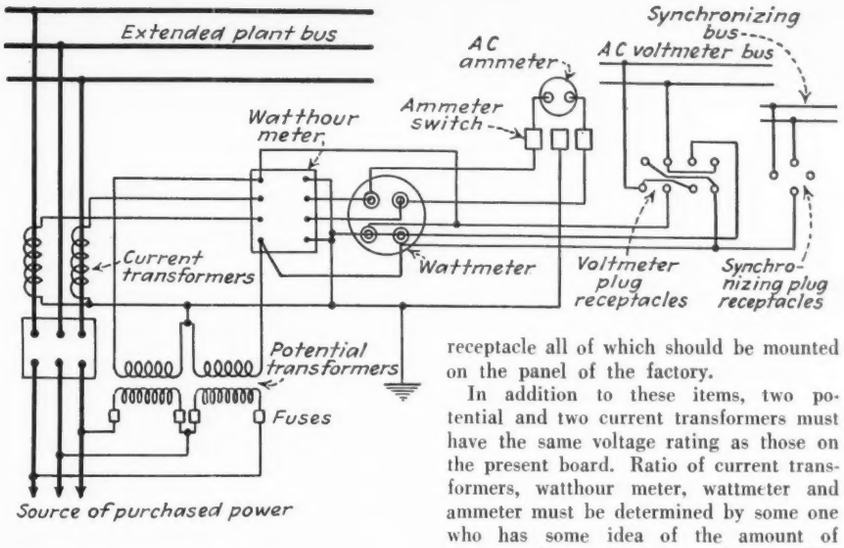
Assuming that the outside source of power has the same voltage frequency,



the problem is quite simple. One of the most important problems is to determine the phase rotation on the two systems. This is not as formidable as it sounds. It simply means that if a three-phase motor is connected to the oil switch on the incoming line it will run in the same direction if connected to either source of power. In the figure this can be done by leaving the oil switch open and closing the disconnect in the leads to the plant turbine. Note the direction of motor rotation, then open the disconnects in the incoming line and oil switch and again note the direction of motor rotation. If the motor rotates the same on either source of power the phase rotation of the two are the same and they can be connected in parallel after being properly synchronized. If the motor is not the same voltage as the power sources, then it may be connected through a bank of transformers. If the motor rotates in one direction on one system and opposite on the other, crossing two of the leads on either system will correct the phase rotation.

If the outside source is the public utility system the company's men will probably do the phasing out and make the final connections, or, at least supervise the job. They will also instruct how to synchronize the two systems before closing the oil switch.

San Diego, Calif. C A LEQUESNE



Equipment Requirements

IT WILL BE NECESSARY for FES to purchase another panel for his switchboard, having one oil circuit breaker, one watthour meter, one indicating wattmeter, one ammeter and switch, one potential-plug receptacle and one synchronizing plug receptacle all of which should be mounted on the panel of the factory.

In addition to these items, two potential and two current transformers must have the same voltage rating as those on the present board. Ratio of current transformers, watthour meter, wattmeter and ammeter must be determined by some one who has some idea of the amount of current that will be purchased. The drawing shows the connections necessary for another panel. Connections should be done by a competent electrician, so that the proper polarity of the transformers will be established to the various instruments and the correct phase relation is obtained between the two power sources.

Wisner, Neb. A K GENTZLER

How to Run the Plant

A SIMPLE SCHEME FOR FES TO USE would be to equip his feeder panel with instruments and synchronizing equipment similar to that which he has on his generator panels for use in synchronizing the generators. Synchronizing the incoming feeder with his station is no different than synchronizing the diesel-engine generators.

In a problem of this kind several important conditions must be met before we can operate these two systems in parallel. After the plant has been paralleled with the outside system, any load change or disturbance on this outside system, will be felt in the plant and the engine governors and generator voltage regulators will attempt to correct for these disturbances. This means that it may be necessary to change the governor and voltage regulator adjustments to make them less sensitive to these outside load changes.

Going into more detail let us consider each condition which must be met in order to synchronize two alternating-current systems properly. The frequency of both sources should be registered on separate meters so that the frequency of one source can be adjusted to be equal to that of the other source. This is also necessary of the voltage indications as we must also adjust the two voltages to be of equal value. These two frequency meters and voltmeters are generally mounted on a common panel with the synchronism indicator, which gives the operator all the necessary indications during the actual operation of paralleling the systems, see diagram.

The meters necessary on the incoming feeder panel will be governed largely by the stipulations in the purchased-power contract. If the contract contains a power-factor clause it will be necessary to have power-factor indications of the load on this feeder so that the necessary corrections can be made by properly adjusting the generator voltage. A zero-center indicating reactive meter connected in this feeder will show what amount of reactive is flowing and also in which direction it is flowing. Generally speaking, a minimum of reactive coming in over the outside lines gives the purchased power a higher power factor, which in turn makes a considerable reduction in the power bill. For efficient operation of generators in parallel, the reactive should be evenly divided between

(*Continued on page* 194)

Figuring Efficiency

By PHIL SWAIN

IN GENERAL, *the efficiency of any machine is the ratio of its useful output to its total input.* To put it another way, the efficiency is the useful output divided by the total input. The result of this division may be expressed either as a decimal fraction or percentage.

A "perfect" machine would have no internal losses; hence its useful output would equal its input, and its efficiency would be 1.00, or 100%. Actual machines always have some internal losses (friction, windage, electrical-resistance losses, hysteresis, etc), so the efficiency of an actual machine must always be less than 100%.

Any convenient unit of energy or power may be used in the efficiency formula to express input and useful output, as long as the same unit is used for both. The accompanying tables give convenient conversion factors. With the aid of these, it is easy to figure the efficiency in any case where input and useful output can be measured directly. The following examples show how:

Motor in Fig. 1 delivers 9.2 hp at its pulley when drawing 8.4 kw from the line. What is motor efficiency at this load? Input and output must be in the same units, so convert the 8.4 kw input to horsepower, using the constant 1.341 from the table. Then,

Input = 8.4 × 1.341 = 11.26 hp
Useful output = 9.2 hp
Efficiency = 9.2 ÷ 11.26 = 0.817 = 81.7%.

In Fig. 2 we have the reverse case, a generator is driven by a steam turbine (not shown). Generator output is 15,200 kw, and input (from the shaft of the turbine) is 23,000 hp. Then,

Input = 23,000 × 0.745 = 17,135 kw
Efficiency = 15,200 ÷ 17,135 = 0.887 = 88.7%.

It is just as easy to figure the overall efficiency of a complete power plant. No understanding of the interior arrangements or equipment is required. For example, it is enough to know that the steam plant shown in Fig. 3 delivered 34,400,000 kw hr of electrical energy in a certain month during which it burned 20,400 tons of coal having a heat value of 13,300 Btu per pound.

In a case of this sort we may take input and useful output on a monthly basis, or work in terms of the input per kw-hr output. Coal fired per month was 20,400 x 2,000 = 40,800,000 lb. This is 40,800,000 ÷ 34,400,000 = 1.186 lb per kw hr.

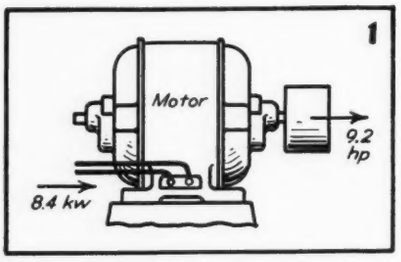
Heat input per kw hr = 1.186 × 13,300 = 15,775 Btu
Useful output per kw hr = 3413 Btu
Efficiency = 3413 ÷ 15,775 = 0.216 = 21.6%.

The hydro plant (Fig. 4) is equally simple, assuming that we want overall efficiency, including the losses in penstocks and tail pipes. Since one cubic foot of water weighs 62.5 lb, 3400 cfs (3400 cu ft per sec) is 212,500 lb per sec. Falling through the total head of 150 ft, this represents an energy supply of 212,500 × 150 = 31,875,000 ft lb per sec. Since one kilowatt equals 738 ft lb per sec,

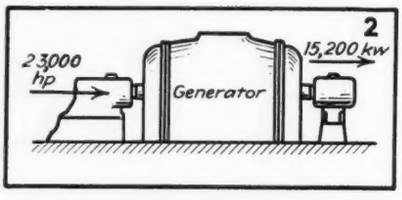
Input = 31,875,000 ÷ 738 = 43,190 kw
Efficiency = 36,000 ÷ 43,190 = 0.834 = 83.4%.

There is room for one more example (Fig. 5)—the motor-driven pump. Find the overall efficiency of the system, including all losses in motor, pumps and piping. In this case the input is electrical energy and the output is the energy in 64,000 lb of water raised 70 ft. Then,

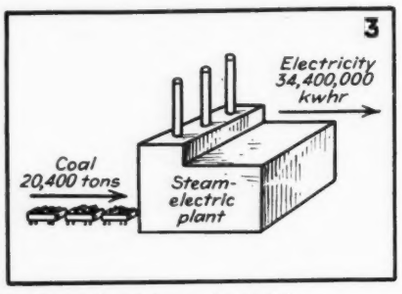
Useful output = 64,000 × 70 = 4,480,000 ft lb per hr
Input = 3.2 × 2,656,000 = 8,499,000 ft lb per hr
Efficiency = 4,480,000 ÷ 8, 499,000 = 0.527 = 52.7%.



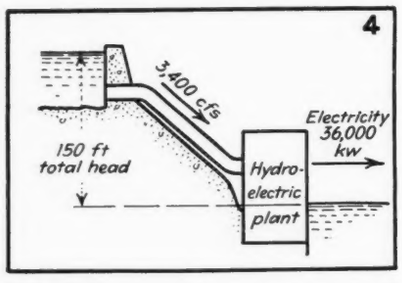
1—Motor efficiency figures 81.7%



2—Generator efficiency is 88.7%



3—Overall efficiency is 21.6%



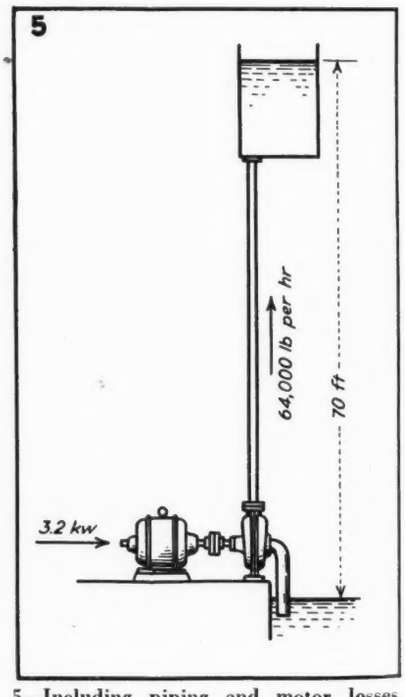
4—Including losses in penstocks and tail pipes, efficiency of this hydro installation is 83.4%

Units of Work and Energy

1 Btu = 778 ft.lb
1 kw hr = 1.341 hp-hr
= 3413 Btu
= 2,656,000 ft.lb.
1 hp hr = 0.745 kw hr
= 2544 Btu
= 1,980,000 ft.lb.

Units of Power

1 hp = 0.745 kw
= 1,980,000 ft.lb. per hr
= 33,000 ft.lb. per min.
= 550 ft.lb. per sec
= 2544 Btu per hr
= 42.4 Btu per min
= 0.707 Btu per sec
1 kw = 1.341 hp
= 2,656,000 ft.lb. per hr
= 44,270 ft.lb. per min
= 738 ft.lb. per sec
= 3413 Btu per hr
= 56.9 Btu per min
= 0.948 Btu per sec



5—Including piping and motor losses. this pumping installation has an efficiency of 52.7%

ARGUMENT CORNER

Aye, Water is a Powerful Force

I WAS A WEE BIT INTERESTED in the article "Experience Report on Turbine Governing Problems," March POWER.

On page 118, there is a picture of a hydroelectric power plant, and the descriptive wording at the bottom of that picture reads: "Governing of hydroelectric units means relatively slow gate movement because of conditions that can develop because of the physical characteristics of the water." All of that is true, and should be borne in mind. Example:

The British Aluminium Co's plant, at Kinlochleven, Argyleshire, Scotland, has the largest hydroelectric power plant in the British Isles. The dam, away up on the Rannoch Moor, was made by joining three small lochs. The total length of the dam is roughly 15 miles, the depth 90 ft at the dam face, the widest part about a mile and a half.

Water flows from the sluice gates in the dam, through the baffling chambers, through a conduit roughly three miles long. This conduit is built of concrete, and covered. The end of the conduit is at the lower penstock, where there are surge chambers, and electric controls. The height of the lower penstock is 999 ft above sea level. The center lines of the Pelton wheels are 30 ft above sea level (mean). The tide rises 18 to 24 ft. Six pipelines, 54 in. in diameter, bring water to the Pelton wheels. Pressure of the water is approximately 460 lb per sq in.

One afternoon, while shutting down a unit, the Assistant Manager of the plant became irritable because of the time required to close the needle valves. The attendant had both hands on the manual-operation wheel, which was geared to the automatic motor gearing, and the whole was functioning smoothly. The attendant's hands were merely a guiding factor, in the event the small motor started to act up. Slowly went round the attendant's hands with the wheel. One complete revolution, then another. Minutes were slipping by, when, with a disgusted grunt, the assistant manager literally ran to the controls, pushed the attendant aside, and seizing the manual-operation wheel with one hand, threw out the gears with the other. Then with two hands he rapidly shut in the large manual wheel.

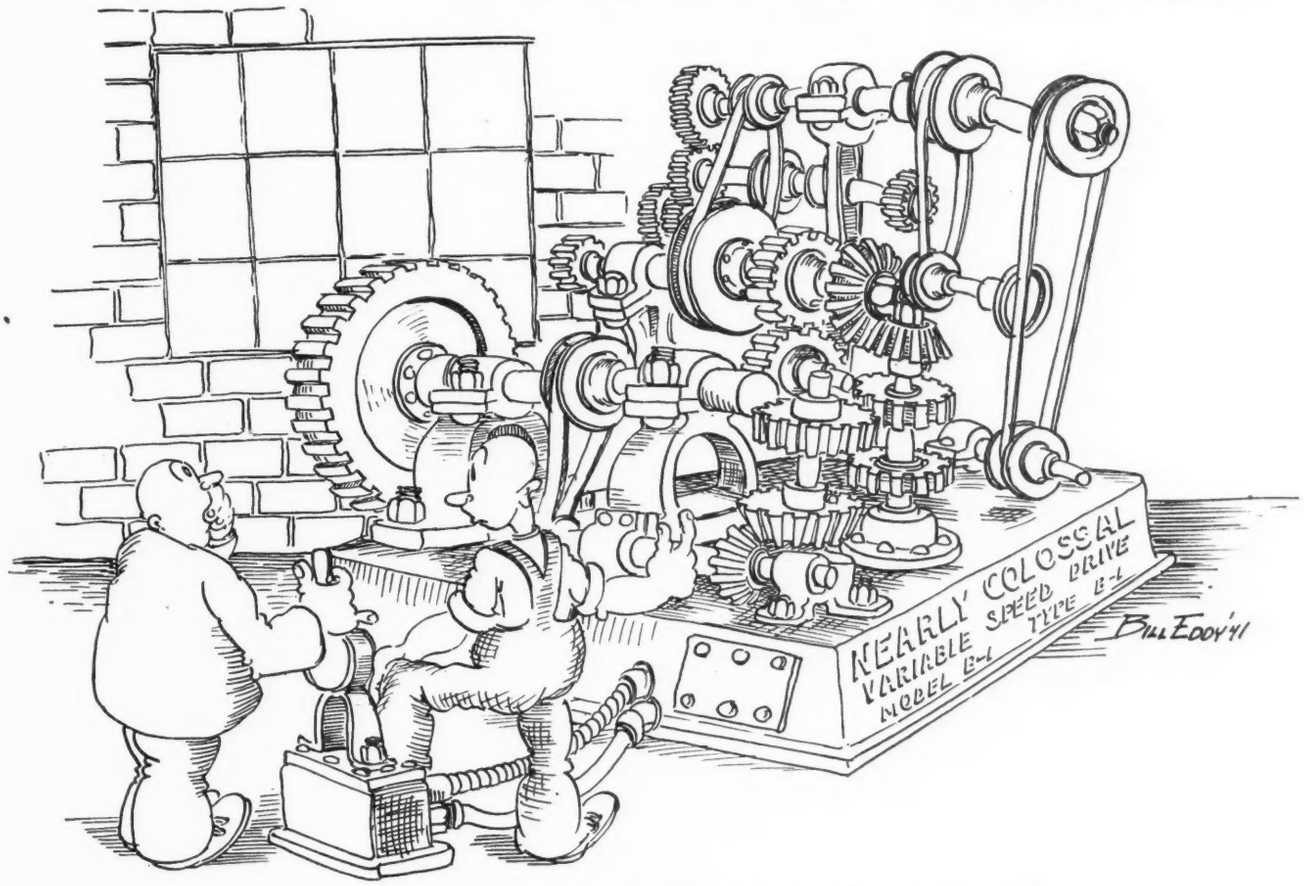
Those that saw this act moved away to a safe distance. Some moved into the furnace room. I didn't see the water spout. The manager was whirled away like a straw.

What saved the day were the automatics, which went in operation, diverting the water flow, and also cutting the penstock valves shut.

The damage was negligible. The governor gears and casings were smashed. Had the automatics not gone into operation, that wheel and the coupled generators would have sailed.

The Pelton-wheel casing was removed, the blades were tested, and the machine run free (this used to be done with a one horse motor belted to the wheel). Pardon me, I said blades. Error, I should have said "buckets".

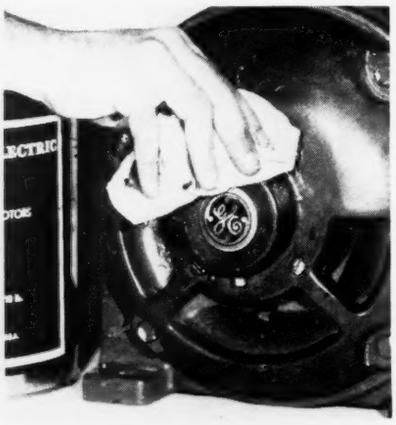
Grand Rapids, Mich. J M GORRIE



"This is our super-speed reducer—No matter what you do, output is zero"

HOW TO GREASE BALL-BEARING MOTORS

► DETERMINING the correct amount of lubricant in anti-friction bearings is one of the most important problems in motor maintenance. Too much lubricant in these bearings can cause heating and other bad effects, just as will too little lubrication. Many motors have ball bearings arranged to be greased with a pressure gun. The following procedure, developed by the General Electric Co based on several years experience, has been used with excellent results on such motors. Preferably, motors should be greased while they are in operation.

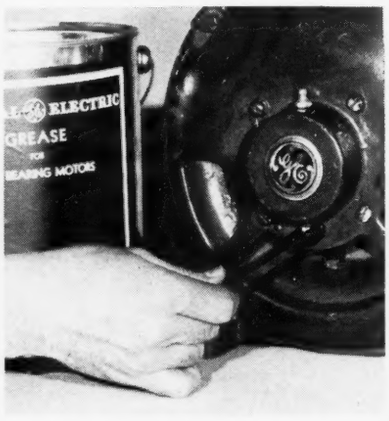


1

Make sure that no dirt gets into the bearing with the grease—wipe pressure-gun fitting, bearing housing and relief plug clean

2

Always remove the relief plug from the bottom of the bearing before using the grease gun. This prevents putting excessive pressure inside the bearing housing that might rupture the bearing seals

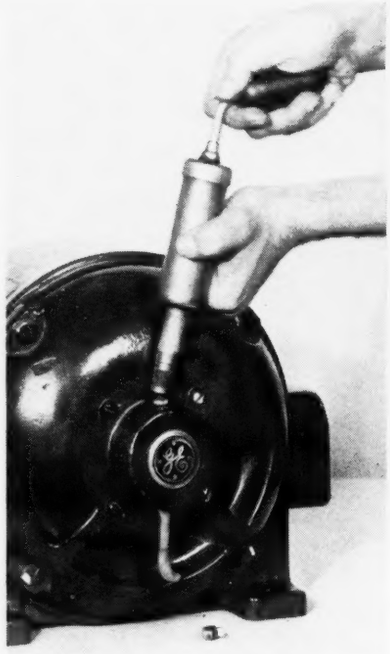


3

With a clean screw driver or similar tool free the relief hole of any hardened grease, so that any excesss grease will run freely from the bearing

4

With the motor running, add grease with a hand-operated pressure gun until it begins to flow from the relief hole. This tends to purge housing of old grease. If it might prove dangerous to lubricate the motor while running, follow this procedure with the motor at a standstill

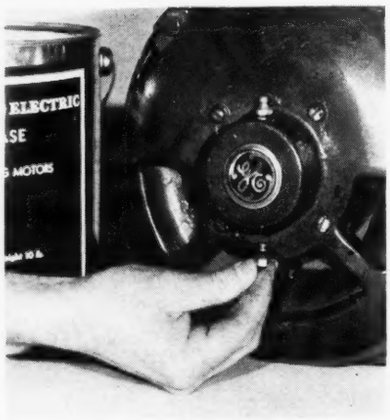


5

Allow the motor to run long enough after adding grease to permit the rotating parts of the bearing to expel all excess grease from the housing. This very important step prevents over-greasing the bearing

6

Stop the motor and replace the relief plug tightly with a wrench

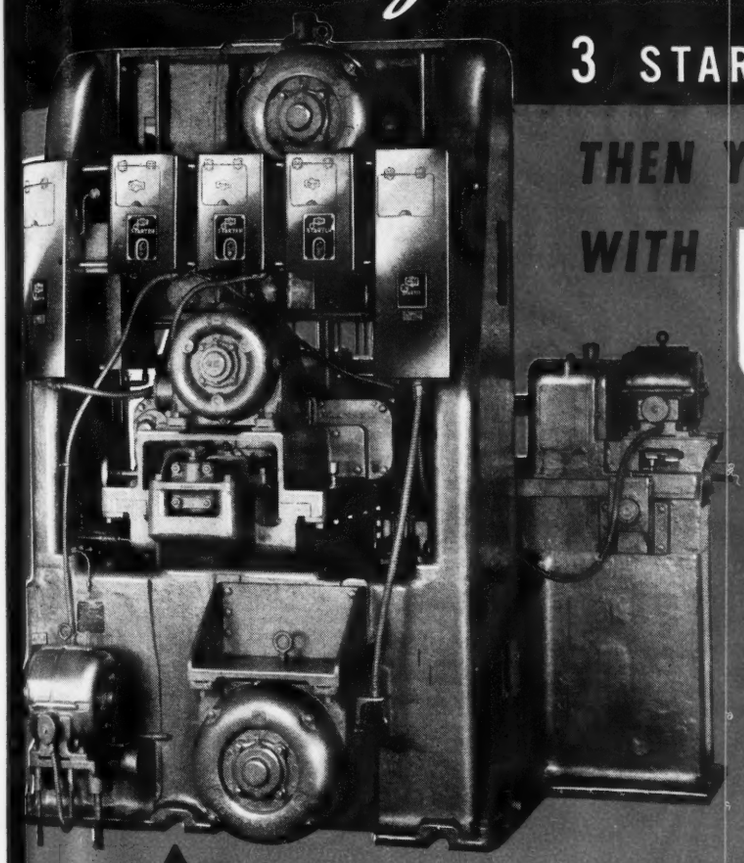


What do you need for your plant—

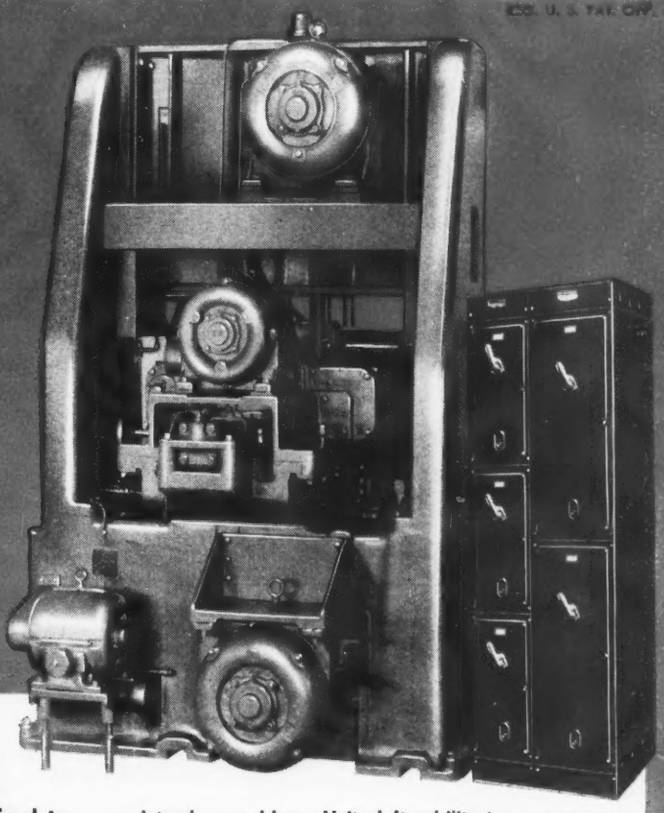
3 STARTERS OR 300 STARTERS?

THEN YOU ARE VITALLY CONCERNED WITH UNITROL

REG. U. S. PAT. OFF.



NOT THIS: It's a lot of work to hang needed controls on a machine . . . or to install them individually nearby. Bulky, inconvenient, space-wasting, costly to assemble and install.



BUT THIS: The same number of Controls takes up little space in a section or two of Unitrol nearby. And it's easy to construct, ship, install, and inspect control when it's built into Unitrol.

1st . . . . The Unitrol Unit

The basic element of Unitrol is a simple unit mounting-frame into which any standard control device may be bolted. This unit frame has integral with it a hinged cover or door which may be blank, or arranged for either dead-front manual or push-button operation of the device enclosed.

2nd . . . The Unitrol Section

is a steel enclosure which houses and supports a group of Unitrol Units. It is constructed of standardized interchangeable members to form the sides, top and back . . . with unique provisions for bus supports, wiring troughs, conduit or duct entrances, etc.

3rd . . . The Unitrol Control Center

consists of a grouping of Unitrol Sections fabricated into a complete sectionalized assembly and delivered ready for installation and use.

Unitrol is the next step forward in Motor Control Practice. But it offers so many advantages that you cannot afford to wait until you are ready to "modernize." Unitrol may have the answer to the problem that has "stopped" you *right now.*

You are invited to bear in mind conditions that face your plant right now, as you read about Unitrol. Unitrol is a new method of housing and installing conventional starters.

The first step is the new Unitrol single unit mounting frame, into which any one of several sizes of conventional starters or control elements can be mounted. The second step is the new Unitrol Sectional frame into which several *unit* controls in *their* frames can be installed. The whole section thus forms a completely enclosed, compact and accessible structure which can be located anywhere, near a machine, against a wall, in a corner and so on. The third step is the Unitrol Control Center composed of more than one section; it is as complete as you want it, extensible, flexible, actually custom-built to your specific and individual needs.

There is no other method of housing and mounting a number of starters as compactly as Unitrol. There is no other method of custom-building a complete motor control center to your individual needs as easily and economically as Unitrol. There is no method as flexible or as interchangeable as Unitrol. Its ability to save space is remarkable. It may eliminate a need in your plant to build plant extensions. It may prove to be just the type of control organization in your plant needed to break a "bottleneck." It grows in size or it contracts in size to keep abreast of your needs. The control elements housed in it may be changed at will, and easily. Its installation requires no special wall or floor preparation. Literally, it can be installed anywhere. Its cost is less than that of even an unsatisfactory substitute.

Unitrol's advantages are so great, its ability to save time, money and space as well as to solve building problems is so extensive that it requires a full-size 36-page booklet to tell them all. This booklet "Unitrol . . . the Next Step Forward in Motor Control" is sent free and without obligation to business executives. Dictate a memo to your secretary now—to send for a copy of this interesting book. CUTLER-HAMMER, Inc., *Pioneer Electrical Manufacturers,* 1358 St. Paul Ave., Milwaukee, Wisconsin.

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C-H

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Fans for Air Conditioning

V C Finch, professor of mechanical engineering, Stanford University, discusses three types of centrifugal fans and tells how to get the most out of them

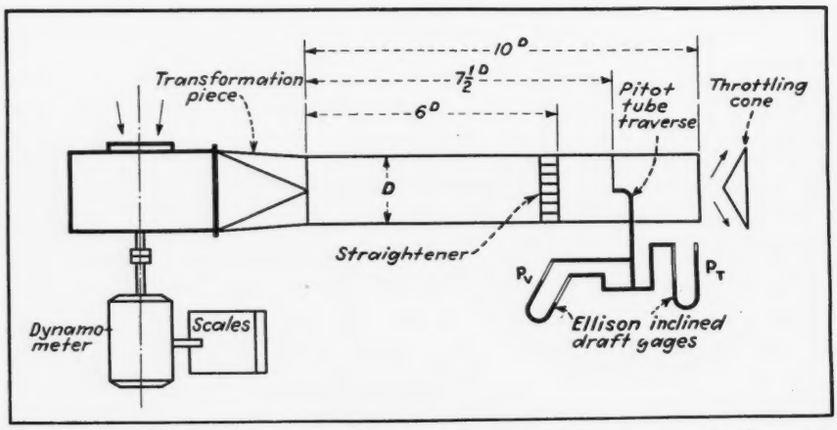


Fig. 1—Fan test requires a long straight discharge duct of area equal to the fan outlet and a throttling cone to regulate flow

▶ FOR VENTILATING AND AIR CONDITIONING, propeller fans and centrifugal fans each have a proper place. Large quantities of air at low pressures call for propeller types. Systems with branch ducts usually have higher resistance to air flow and require higher pressures than present propeller fans economically provide.

Air distribution in duct systems is accomplished by one of three types of centrifugal fans distinguished from each other by the tilt angle of their blades with respect to impeller rotation. These are (1) forward-curved blade or high velocity (2) straight blade, medium velocity and (3) backward-slope blade, low velocity.

The specific difference in the three types is in the direction of blade curvature at the delivery edge as affecting the air velocity leaving the blade tip. Each has advantages and disadvantages as noted in the table below.

The output of any fan is in proportion to the product of the pressure and volume of air delivered. Air enters the fan housing, the rotating impeller does work upon it, and the air is discharged at higher pressure. In all centrifugal fans there are two sources of pressure (1) due to centrifugal force from the forced rotation of the air column inclosed in the impeller, and (2) due to kinetic energy of the air because of its velocity leaving the blade tip.

The amount of centrifugal force imparted to the air depends on the ratio of the rotational velocity entering to that leaving the impeller. When the flow of air is partially blocked, the centrifugal force component produces compression or static pressure.

Some of the kinetic energy of the air leaving the blade tips is converted to static pressure in the spiral casing. This conversion follows the principle that when the velocity is decreased the pressure is increased and vice versa. The conversion occurs in the casing surrounding the impeller. Air leaves the blade tips at high velocity and low pressure. In the stationary casing it slows down and the pressure increases.

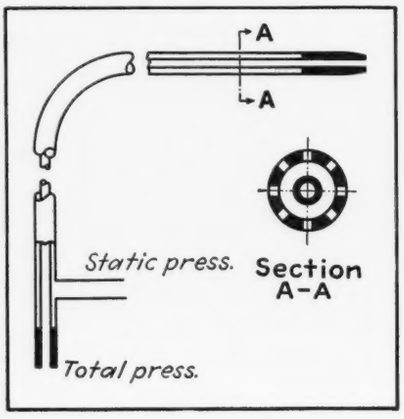


Fig. 2—Standard form of Pitot tube for measurement of flow by traversing test discharge duct

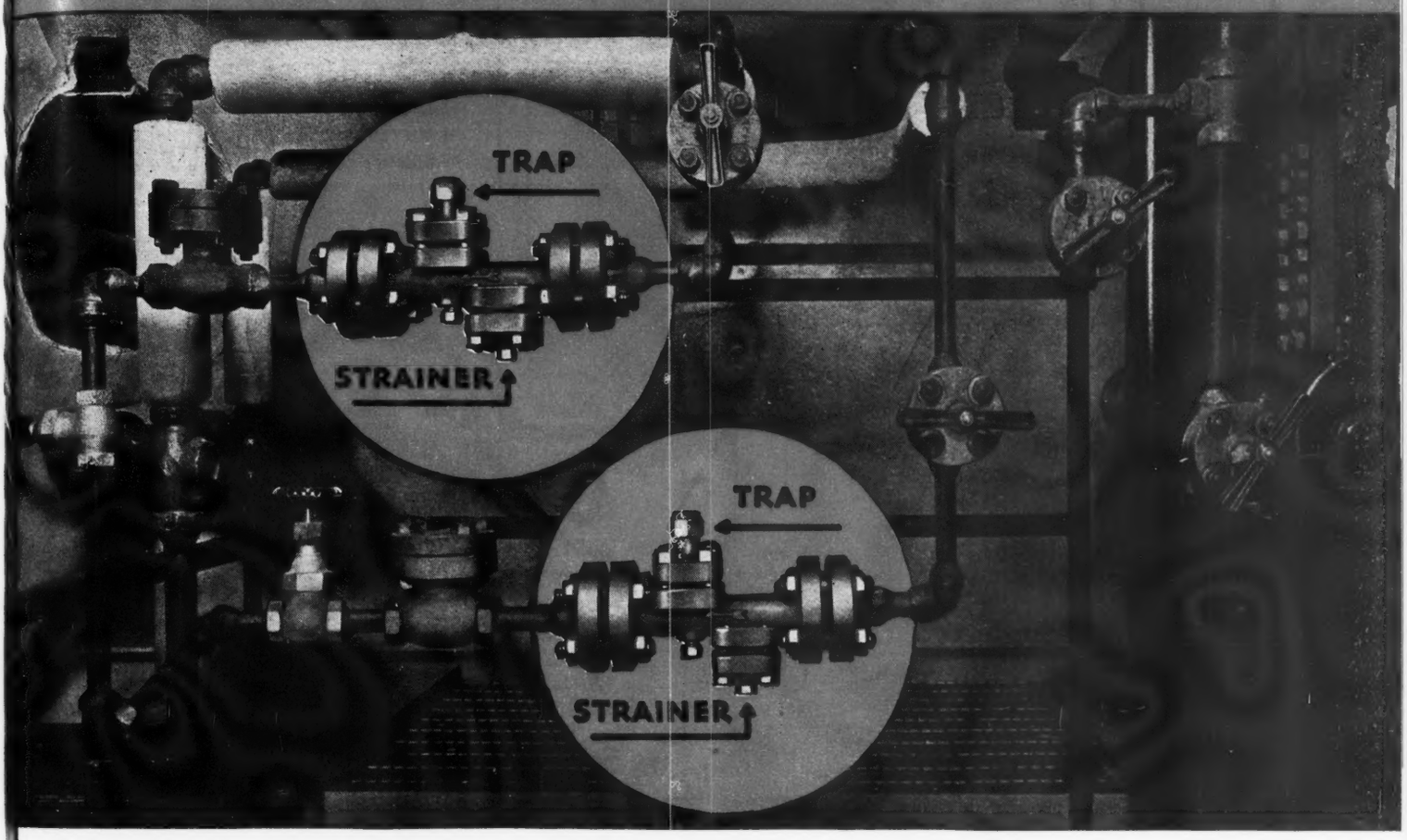
The gradually enlarging volute shape of the spiral casing allows a smooth and efficient conversion of the kinetic energy of the high-velocity air to the potential energy of static pressure needed to overcome friction in ducts and distribution system. Further conversion of velocity energy to static pressure can be brought about by divergent-shaped transformation pieces connecting fans to ductwork.

Some of the kinetic energy remains unconverted to static pressure and becomes the motive force that moves the air along through the duct system. As a unit mass of air leaves the fan, it is acted upon by both static and velocity

(*Continued on page* 114)

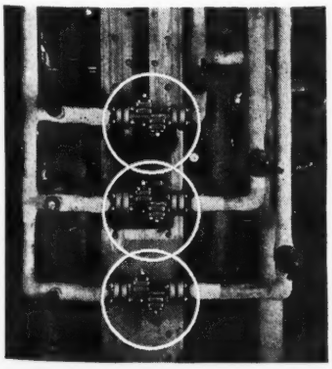
Fan Type	*Advantages*	*Disadvantages*
Forward-curved-blade fan	Occupies less space Weighs less Low price Low tip speed High air velocity leaving wheel	Sensitive to inlet disturbances Lower efficiencies Has unstable dip in pressure curve Not suitable for parallel operation Horsepower curve rises with reduced resistance
Straight-blade fan	Operates well in parallel Can handle dust and soot Lower tip speed than backward-slope blade fan	Lower efficiency than backward-slope-blade fan Horsepower curve rises with reduced resistance
Backward-slope-blade fan	Highest efficiency Non-overloading power characteristic High speed permits direct connection to electric motors Operates perfectly in parallel	Higher cost Cubical space required about double that for forward-curved-blade fan Weighs more

YARWAY "SUPER PRESSURE" TRAPS at Detroit Edison Company



Above: Yarway Impulse Steam Traps on superheater drip lines at Delray Station of Detroit Edison Company.

Yarway Impulse Traps and Integral Strainers Used at Conners Creek and Delray Stations



Above: Three Yarway Impulse Steam Traps on emergency stop valve, boiler-feed-pump turbine, and 200 lb saturated steam line at Delray.

After exhaustive tests and careful research, Detroit Edison has put Yarway Impulse Steam Traps to work draining emergency stop valves, superheater drip lines and main steam manifolds.

The Yarway Impulse Traps offered for such service were designed for pressures up to 1500 lb and temperatures up to 920° F. They are a special development embodying the same operating principle as the popular Yarway Trap found almost everywhere.

Of steel construction with integral strainers, they are supplied with flanged or welding ends.

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Like lower pressure Yarway Traps, these traps offer the same advantages such as quicker draining and greater sustained efficiency—small size, saving space—light weight, requiring no support—straight through piping, simplifying installation—only one moving part and rugged construction, cutting maintenance cost. Then, too, there is no need to change valve or seat for widely varying pressures.

And when you consider that their average cost is usually no more than the cost of repairing an ordinary trap—why not get Yarway performance for your money? More than 90,000 have been installed.

A nearby Mill Supply Dealer handles Yarway Impulse Traps. Or write for Catalog T-1735.

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YARWAY IMPULSE STEAM TRAP

(Continued from page 112)

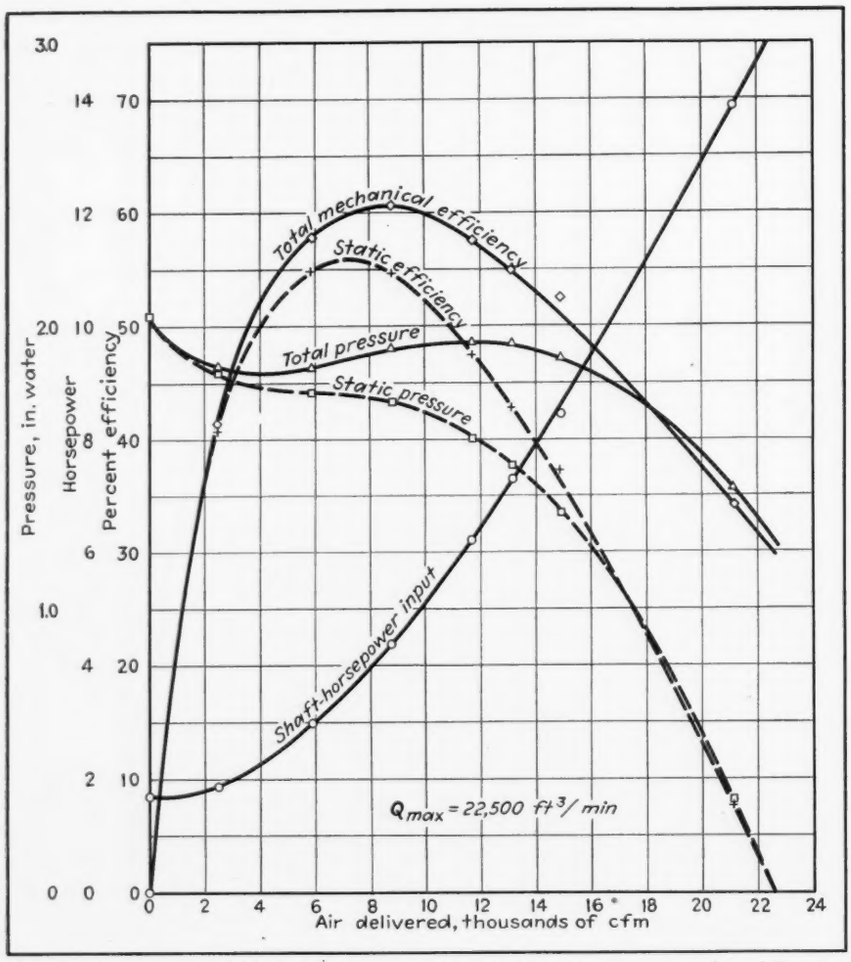

Fig. 3—Forward-curved blade fan gives unstable dip in static pressure at low deliveries

pressures. These two pressures, at any one point, are distinct. However, they are interrelated in that an increase of velocity, made necessary by a smaller cross section of duct, demands transformation of part of the static pressure to velocity pressure to move the air faster. If the velocity is then decreased by enlarging the duct, part of the velocity pressure can again be converted back to static pressure.

Of the two pressures created by the fan impeller, static pressure is a force tending to compress the air while velocity pressure is the energy required to accelerate the flowing mass of air to its existing velocity. Static pressure acts equally in all directions, tending to burst the duct as well as compress the air. Velocity pressure acts only in the direction of flow.

The sum of the static and velocity pressures at any point is termed "total pressure." It is often called "impact" pressure. Since one of the components is velocity pressure, total pressure must be measured in the direction of flow.

The performance of a fan impeller depends greatly on the casing in which it is placed. Volume, pressure and efficiency depend on shape, length, depth, curvature, tilt, and number of blades. Losses include (1) entry (2) surface friction (3) shock losses, and (4) disk friction. Entry losses can be minimized by a conical or bell-shaped inlet. The conical shape is preferable from the standpoint of manufacture.

Surface friction is reduced by fabrication of the casing and impeller to provide a smooth channel devoid of obstructions and projections. Shock loss, from sudden change in either velocity or direction, can be reduced by carefully developed flow paths such as the spiral volute casing.

The rotating impeller is enveloped in a sheath of air that rotates with it. The particles of the boundary of this rapidly moving sheath are in contact with particles of slower moving air in the casing. The drag of the particles on each other causes disk friction. Little is known of the magnitude of the loss, but it is presumed to be small in comparison with the other losses.

On the test stand, fan performance is determined by connecting a long straight duct to the fan discharge and driving the fan by an electric dynamometer. During any one test the fan runs at constant speed. The open end of the discharge duct is first blocked completely with a cone-shaped throttling device and a measurement of static pressure made. There can be no velocity pressure with no air flowing through the duct.

Next the throttling cone is moved out until about 10% of the duct area is opened and readings of both static and velocity pressure taken. This procedure is repeated with duct openings every 10% or so up to wide open. From the velocity pressures, volume or quantity of air flow is computed. A curve showing the change of pressure with change in flow is called the fan "characteristic."

Characteristic Curve

This curve represents every volume and corresponding static pressure the fan can deliver at a given speed. The resistance pressure of any reasonable system of ductwork to which the fan may be connected must fall on some point of this characteristic curve. The volume flow expected at that pressure can be read from the volume scale.

Horsepower input, computed from the dynamometer readings, is usually plotted on the same sheet with the fan characteristic. Usually all readings are corrected to standard air conditions of 0.075 lb per cu ft, corresponding to 29.92-in. barometer, a dry-bulb temperature of 68 F and 50% relative humidity.

The discharge-test duct is required by the National Association of Fan Manufacturers to have an area equal to that of the fan outlet, to be of uniform circular cross section, and be not less than 10 duct diameters in length. The point of measurement of the pressures must be at least 7½ duct diameters away from the transformation section joining the fan to the test duct. Fig. 1 shows the fan-test arrangement in the Stanford laboratory.

Pressures, measured at some distance down the duct from the fan outlet, must be corrected for duct friction. The usual relation is

$$p_f = 0.02 \frac{L}{D} p_v$$

where

(*Continued on page* 116)

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WATERBURY, CONN.

(Continued from page 114)

p_f = pressure loss due to friction, in. wg

L = distance from fan to measurement station, ft

D = duct diameter ft.

Pressure loss due to an air straightener may be taken as equal to the loss in four duct diameters as calculated by the formula.

Volume measuring devices include (1) pitot tube (2) orifice, and (3) nozzle. No one of these devices is entirely satisfactory for measuring the volume of air delivered by a centrifugal fan from zero to maximum. The pitot tube does not provide accurate measurement of low discharge; neither orifice nor nozzle allows wide-open operation.

Since the pitot tube method is accurate for high discharge rates, which usually include the range of maximum efficiency, the National Association of Fan Manufacturers has specified this method as standard. The double pitot tube, Fig. 2, in the form suggested by Professor L S Marks (Trans ASME, Oct, 1935) is the standard instrument for measuring pressure. An open-end ⅛-in. tube is bent to point upstream and thus receive total or impact pressure. A closed coaxial $\frac{5}{16}$-in. tube surrounds the impact tube and is perforated with a ring of 0.04-in. holes to admit the static pressure.

A manometer connected across the two tubes reads total pressure minus static pressure, or, the net velocity pressure. A tee in the total pressure line also leads to an open-ended manometer reading the total pressure directly.

The rate of flow through a duct is greatest near its axis and least near its wall. Therefore, arrangement must be made for measuring velocity pressure at many points across the duct. At least two traverses, one across a vertical and another on the horizontal diameters are specified by NAFM. Readings are taken in equal-area concentric zones across the section of the duct. Distances from the center of the duct for equal-area zones are 31.6, 54.8, 70.7, 83.7 and 96.1% of the radius.

The average of the pressures obtained with the pitot tubes and the corresponding readings of load and speed of the dynamometer driving the fan provide data for the curves of fan performance, Fig. 3. All factors are plotted against volume of air delivered and are corrected to some constant speed and air density.

The characteristic curves of an entire group of fans may be represented by plotting the results of one fan test on a percentage basis, as in Fig. 4, provided the fans are geometrically similar, but of different size.

Forward-Curved Blades

Figs. 3 and 4 represent the performance of a forward-curved-blade fan. The unstable dip in the pressure curves at low deliveries is characteristic of the forward-curved blade. It does not appear in the pressure curves of straight or backward-curved blades. This dip is thought to be the result of two related causes. First, with forward-curved blades, the velocity of air leaving the blade tips is higher than in the other types. This necessitates larger scroll casings to obtain more complete conversion of velocity energy to static pressure. Second, when the fan operates against a considerable resistance, there is a tendency for the air to leak back through the impeller.

Since there is a higher static pressure in the casing of the forward-curved-blade fan, the leakage back through the wheel will be greater. At zero delivery this leakage is of no consequence, but as the flow is increased, leakage acts to relieve the high static pressure in the casing.

The maximum static pressure in the casing is at the discharge opening. It is in this region that the air coming through the impeller has little chance to convert its velocity energy to pressure energy. In this section of the casing the impeller is said to be exposed since it is attempting to deliver air almost directly to the discharge.

The portion of the impeller exposed extends to the point of cutoff where the curve of the spiral scroll approaches an intersection with the impeller. When the static pressure at the discharge opening builds up because of restricted flow, there will be sufficient leakage back through the exposed portion of the impeller to cause a droop in the static pressure curve. In the selection and application of forward-curved blade fans it should be realized that the working range of the fan must be entirely at flows greater than the point of instability.

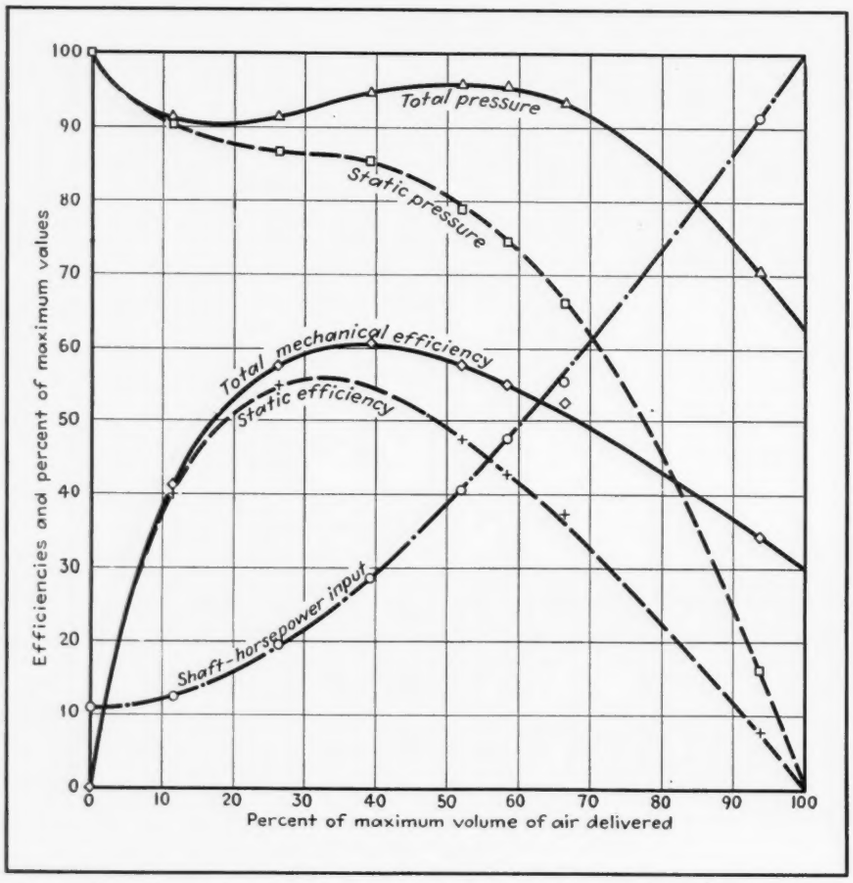

Fig. 4—Approximate characteristics of an entire group of fans may be taken from tests of a single one plotted in percent of pressure and volume

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Power for the Battle of Production

Defense problems and how to meet them forms major theme of engineering discussions at Midwest Power Conference

▶ THE JOB OF MEETING the power demands of the "battle of production" bulked large in the papers and discussions of power engineers attending the Midwest Power Conference, held April 9 and 10, in Chicago. From the "off the record" talk on power facilities and the defense program by C W Kellogg, Chief Consultant of the Power Unit, Office of Production Management, through sessions on central station and industrial power, hydroelectric developments, feedwater treatment and electric power transmission the problem of defense loads and how to meet them held the center of the stage.

Stating that today's trends in power development are influenced by recent economic and political events, A G Christie, The Johns Hopkins University, traced the effect of the depression years, government power policy, the boom of 1937 and the current emergency on power development. An important part has been played in these recent years by hydro power; today government projects fill vital industrial power needs not visioned when they were started. Although hydro plants and long transmission lines are vulnerable from a military viewpoint, Prof Christie predicted continued expansion of these developments.

Modern Steam Plants

Comparing today's high-pressure high-temperature steam plants with those of the turn of the century, Prof Christie showed how advances in materials and equipment design brought about changes. The probable future trend will be toward stations of moderate size, more use of radiant heat in boilers, greater attention to ash characteristics in furnace design, extended use of welding in boilers and piping, continued development of 3600-rpm hydrogen-cooled turbine generators, and wider adoption of dust collecting devices. These advances in turn require better trained and more skilled operators. Efficiency increases may be nullified somewhat by increase in fuel cost.

At a luncheon session sponsored by the Chicago Section of the ASME, Alfred Iddles, Babcock & Wilcox Co, discussed what "The User Wants to Know" in regard to plant equipment. Stressing the importance of close cooperation between the four parties involved in selection and installation of power equipment—the owner, the operator, the designer and builder, and the equipment manufacturer—he indicated that the user should have three kinds of information: (1) conditions which equipment must meet, (2) experience and ability of the manufacturers who offer equipment, (3) the peculiar requirements which may be imposed by geographic location and plant operating practices. With numerous practical examples, Mr Iddles showed the effect of various factors on equipment selection, underlining the importance of starting the job of buying equipment with complete information, with full cooperation between all parties and without imposition of impractical or uneconomic requirements growing out of lack of full knowledge of the entire situation.

C W Kellogg (center), chief consultant of the Power Unit, OPM, with C C Frank (left), Westinghouse, and J I Yellott, Armour Institute of Technology

In a session devoted to central-station practice, F H Rosencrants, Combustion Engineering Co, described the general features of the forced-circulation La-Mont boiler to be installed at Montaup Station. This unit, designed to produce 650,000 lb per hr of 2000-lb, 960-F steam, is nearly twice as large as the biggest of this type yet built, the 350,000-lb-per-hr boiler at Deptford West, England. Citing advantages of forced circulation, Mr Rosencrants stated that the small tubes used facilitate welding and thus eliminate rolled joints. Small tubes also give turbulent flow, minimizing steam film on inside of tubes and decreasing temperature drop through the tube wall. Circulation at a rate sufficient to move all water in the unit once every 40 sec largely eliminates possibility of "chemical hideout" and is believed to give a wider margin of safety in water treatment. Thermal capacity of metal and water in the boiler is about one-half that for a natural circulation unit, producing quicker pickup. There is, however, no efficiency gain from forced circulation; efficiency may run a fraction of a percent less because of power required for pumping.

Turbine Developments

Speaking on "Modern Steam Turbine Design," C C Franck, Westinghouse, gave a comprehensive summary of turbine development, with particular emphasis on the steps taken to overcome early difficulties with the typical high-pressure high-temperature units of today. Metallurgical research into creep properties of metals and use of X-ray and gamma-ray investigation gave the answers to several high-temperature problems. Improved design of turbine

(*Continued on page* 120)

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"The User Wants to Know" was theme of talk by Alfred Iddles, B & W

mountings takes care of extremes of expansion met at high differential temperatures. Recent studies show the need for designing blading that will be safe under resonant conditions, particularly in the case of first-stage wheels operating under partial admission. Improving flow conditions through blading, use of "water catchers," streamlined lashing wires, and Stellite blade shields contribute to solving the erosion problem in the last stages. Carefully controlled washing with saturated steam proves successful in removing blading deposits resulting from carryover. Development of the "Kuebler test" for determining the rusting propensities of turbine oils eliminates rusting troubles encountered in machines of the 1935–37 period. New stator suspension methods and cross-slotting the rotor cure vibration problems and journal "whip" in 3600-rpm generators. Mr Franck stressed the fact that these detail design improvements, resulting from operating experience of the past few years, insure units of proven design for the current enormous building program of the central-station industry.

Principal reasons for use of variable-speed drive on power-plant auxiliaries are economies resulting from (1) power saving, (2) relief from maintenance, and (3) accurate regulation for best plant operation, according to G V Edmondson, American Blower Corp. Comparing advantages of various methods of varying speed and outlining the requirements such speed-changing devices must meet, Mr Edmondson illustrated his discussion with detailed descriptions of the pump-controlled and the scoop-controlled types of hydraulic couplings.

Getting more out of existing equipment was the general theme of a session on industrial power. R S Hawley, University of Michigan, likened the power plant to a factory and showed how economical operation depends on control of raw materials: fuel, water, and air. He laid particular stress on the need for proper selection of coal, use of care in handling coal, keeping boiler heating surfaces clean, instructing operators in combustion-control principles, even where automatic control is provided, elimination of steam and condensate waste, and scientific water treatment.

Instruments to provide the necessary guide for operation, and controls to regulate operating conditions automatically, will increase output of existing

L W Wallace, Director of Engineering & Research, Crane Co, at luncheon

boiler plants, according to C W Parsons, Republic Flow Meters Co. Combustion meters insure economical utilization of fuel, draft indicators guide boiler operation and maintenance, temperature recorders warn of trouble, and flow meters tell where steam goes and show ways of saving it, always assuming that the meters are really used by the operating force. Automatic controls give a quality of operation that would only be possible with an excessively large force of highly-trained and capable operators. Having pointed out the need for controls and instruments, Mr Parsons discussed the construction and operation of typical modern units.

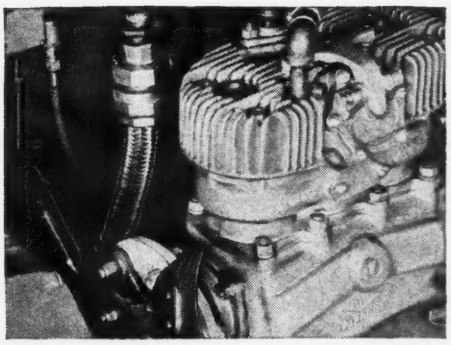
A paper by John T Davis, Indianapolis Power and Light Co, described the arrangement by which this company supplies steam and power to industrial plants in nearby areas on a mutual interchange basis. This utility now supplies high-pressure steam to 11 large industrial concerns, including a paper mill, brewery, two large hotels, a laundry, a Federal Housing project, a tool manufacturer, a drug concern, and a large meat packer. Four of these generate part of their own electrical requirements. This interchange arrangement saved investment in new plant facilities for several of the industrial companies, provides reliable and economical steam and power, and has protected the utility's revenue, thus proving a mutually satisfactory plan.

Feedwater Treatment

At a session on feedwater treatment, F G Straub, University of Illinois, divided water troubles into four general groups: scale, corrosion, embrittlement, and carryover. In low pressure plants internal treatment may be adequate up to 30–40% makeup, with proper blowdown, but for higher pressures pretreatment is necessary, with, in some cases, internal treatment as well. Deaerating heaters prove a major weapon against the oxygen and CO_2 that usually cause corrosion, although some additional chemical treatment may be necessary. Proper operation of deaerators is vital. Experience seems to show that maintenance of ASME ratios eliminates embrittlement; use of welding in fabrication of modern boilers makes embrittlement almost impossible in these units. Recent tendencies put more emphasis on control of carryover problems; this may be effected by continuous

(*Continued on page* 122)

W J Rheingans, Allis-Chalmers, described Kaplan turbines at Pickwick



In this use seamless bronze flexible tubing stands up under pressure as heavy as 300 lbs. and heat as high as 250°F.

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But that's only part of the story. The hose that's used here must be able to withstand heat as high as 250°F. generated by powerful diesel bus motors—and at the same time it must be flexible enough to absorb the constant vibration encountered on the road. Seamless bronze flexible tubing can easily beat the heat because it's *all* metal)—while the fact that it's as flexible as garden hose takes care of the question of vibration.

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check of steam purity to reduce carryover to a minimum or by treatment to make carryover non-adherent.

A E Kittredge, Cochrane Corp, described the methods of analysis developed in recent years to study and predict performance of equipment for removing dissolved gases from water. This analysis points to the greater efficiency of high tray stacks as compared with shallow ones, indicates that direction of steam flow across the tray stack is inconsequential, and shows that in spray or atomizing deaerators means should be provided for maintaining a constant pressure drop across the atomizing valve. Complete removal of CO_2 or ammonia from a water supply otherwise neutral is only practically possible at the present time by use of an acid or a base to drive the ionized fractions of the respective gases into a removable form.

Starting with a paper by R B McWhorter, Federal Power Commission, which comprehensively outlined the present and future hydroelectric development of the United States and the part this development will play in the national emergency, the session on hydro power progressed to a discussion of the operation of a typical multi-purpose project, by S M Woodward, TVA, and to a description of the construction features of the 48,000-hp Kaplan turbines for the Pickwick Landing Dam of the TVA, presented by W J Rheingans, Allis-Chalmers Mfg Co.

Power Transmission

The session on electric power transmission included papers by H E Wulfing, Commonwealth Edison Co, on "The Limitations Placed on Power Transmission by System Stability," and by W J MacLachlan, General Electric Co, on "Trends in Equipment Design in Relation to Economics and Defense." At a luncheon sponsored by the AIEE, Major C W Leihy spoke on "Aspects of the National Power Pool, Defensively and Afterwards." A dramatic appeal for intelligent application of the selective service act to avoid hamstringing industry by accentuating the growing shortage of young engineers was made by Harvey N Davis, President, Stevens Institute of Technology, at the "All Engineers" dinner.

The conference was sponsored by the Illinois Institute of Technology with the cooperation of Iowa State College, Michigan State College, Purdue University, State University of Iowa, and the universities of Illinois, Michigan, and Wisconsin. Other cooperating organizations included the Chicago sections of the AICHE, AIEE, AIME, ASME, ASCE, the Illinois section of the ASCE, the Illinois chapter of the ASHVE, and the Western Society of Engineers.

✦ ✦ ✦

Southern Power Engineers Gather in Atlanta

Boiler operation features ASME discussion at annual spring meeting. New steam plants at Macon and Chickasaw and hydro units at Norris and Hiwassee are described

▶ DETAILS OF CONSTRUCTION of Commonwealth & Southern's new installations in Alabama and Georgia, presented by E C Gaston, indicate that the ideal of duplicate equipment arrangement under quite different foundation and building conditions can hardly be carried out in practice. Circulating water location at Chickasaw, and low condenser head room at Macon were controlling features, he said. However, duplicate 40,000-kw turbine units each supplied by a single steam generator, will start operation this summer. The 900-lb, 900-F steam conditions, said Mr Gaston, were selected as being most economical for expected load conditions; additional investment for higher pressure did not seem advisable.

Experience with local coals in dry-bottom furnaces, reported Allan Luke, Jr, combustion engineer for West Virginia Pulp & Paper, led to several experimental steps in development of slag tapping. Now coals of a similar character are dry-fired in some boilers and tapped in others with success.

Development of a satisfactory water-purification system to permit 100% treated soft water to be used in a 1400-lb boiler was reported by D C Carmichael of E I DuPont de Nemours & Co. Experimental treatment preceded the decision to install high-pressure boilers in necessary plant extension to serve the dye works. A 2-stage water-treatment system was necessary, he concluded, to remove color as well as elements that would affect boiler operation.

For those designers faced with control of combustion air in forced- and induced-draft fans, P S Dickey and H L Coplen of the Bailey Meter Co presented the results of research on damper characteristics. Size of damper, the authors state, is the most important criterion of performance. Predicting the flow through a given damper requires knowledge of the characteristic of the rest of the system, boiler, ductwork etc. Precise information, included in the paper, enables designers to calculate flow so that damper regulation can be adjusted to give even flow change for increments of damper motion whereas previous design had to be mostly guesswork. Louvre dampers have decidedly different characteristics near closing, state the authors, from those of single-leaf dampers.

A report of the development of a multi-fuel burner to handle tar and fuel-pitch as well as oil and coal was presented by W J Lutz of the Gas Department of Public Service Electric and Gas Co of New Jersey. Success resulted from several modifications of the usual multi-fuel type burner so that each of the available refuse fuels could be burned with efficiencies comparable to those that could be obtained with burners designed to burn each single fuel. Fuel-pitch, available at low cost, must be kept below its softening temperature until close to the furnace so that particles will not agglomerate, choke the burner and burn incompletely.

Utilization of "refuse" coals was the subject of extended discussion by J A Reich and F H Spies of Virginia Electric & Power Co. Many local coals were available, stated Mr Reich, that might have to be burned if the present industrial emergency required priority for the good grades ordinarily available in quantity. At considerable expense to the utility, changes were made to the coal-handling system at 12th St station

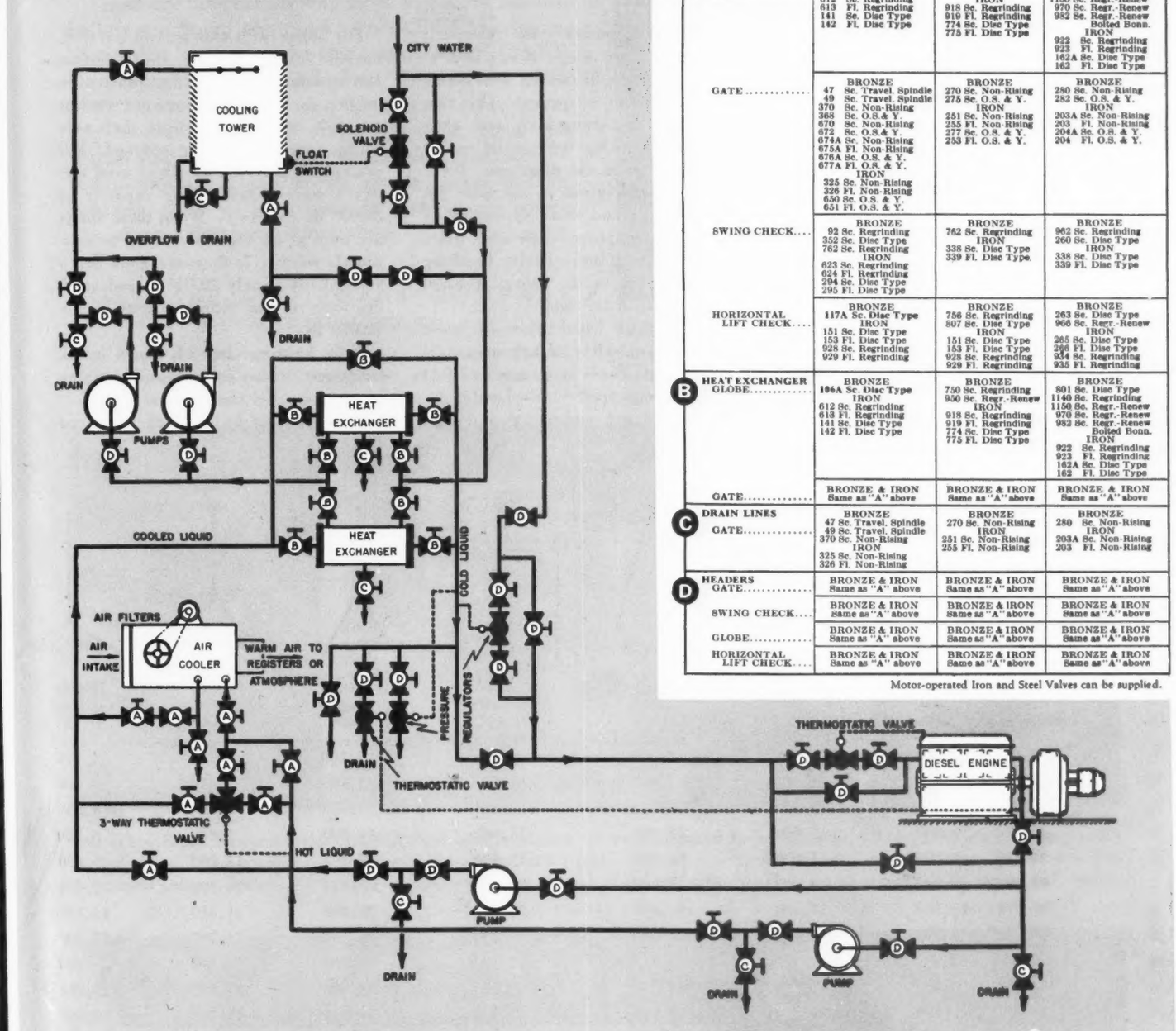
(*Continued on page* 164)

. . TO GOOD VALVE *PRACTICE* . .

FOR COOLING WATER SYSTEMS . . .

Jenkins RECOMMENDS . . .

INDUSTRIAL PLANT



REFERENCE CHART FOR JENKINS FIGURE NUMBERS

		Standard	Medium	Extra Heavy
A	COOLING TOWERS AND AIR COOLER GLOBE	BRONZE 106A Sc. Disc Type IRON 612 Sc. Regrinding 613 Fl. Regrinding 141 Sc. Disc Type 142 Fl. Disc Type	BRONZE 750 Sc. Regrinding 950 Sc. Regr.-Renew IRON 918 Sc. Regrinding 919 Fl. Regrinding 774 Sc. Disc Type 775 Fl. Disc Type	BRONZE 801 Sc. Disc Type 1140 Sc. Regrinding 1150 Sc. Regr.-Renew 970 Sc. Regr.-Renew 982 Sc. Regr.-Renew Bolted Bons. IRON 922 Sc. Regrinding 923 Fl. Regrinding 162A Sc. Disc Type 162 Fl. Disc Type
	GATE	BRONZE 47 Sc. Travel. Spindle 49 Sc. Travel. Spindle 370 Sc. Non-Rising 368 Sc. O.S.& Y. 670 Sc. Non-Rising 672 Sc. O.S.& Y. 674A Sc. Non-Rising 675A Fl. Non-Rising 676A Sc. O.S. & Y. 677A Fl. O.S. & Y. IRON 325 Sc. Non-Rising 326 Fl. Non-Rising 650 Sc. O.S. & Y. 651 Fl. O.S. & Y.	BRONZE 270 Sc. Non-Rising 275 Sc. O.S. & Y. IRON 251 Sc. Non-Rising 255 Fl. Non-Rising 277 Sc. O.S. & Y. 253 Fl. O.S. & Y.	BRONZE 280 Sc. Non-Rising 282 Sc. O.S. & Y. IRON 203A Sc. Non-Rising 203 Fl. Non-Rising 204A Sc. O.S. & Y. 204 Fl. O.S. & Y.
	SWING CHECK	BRONZE 92 Sc. Regrinding 352 Sc. Disc Type 762 Sc. Regrinding IRON 623 Sc. Regrinding 624 Fl. Regrinding 294 Sc. Disc Type 295 Fl. Disc Type	BRONZE 762 Sc. Regrinding IRON 338 Sc. Disc Type 339 Fl. Disc Type	BRONZE 962 Sc. Regrinding 260 Sc. Disc Type IRON 338 Sc. Disc Type 339 Fl. Disc Type
	HORIZONTAL LIFT CHECK	BRONZE 117A Sc. Disc Type IRON 151 Sc. Disc Type 153 Fl. Disc Type 928 Sc. Regrinding 929 Fl. Regrinding	BRONZE 756 Sc. Regrinding 807 Sc. Disc Type IRON 151 Sc. Disc Type 153 Fl. Disc Type 928 Sc. Regrinding 929 Fl. Regrinding	BRONZE 263 Sc. Disc Type 966 Sc. Regr.-Renew IRON 265 Sc. Disc Type 266 Fl. Disc Type 934 Sc. Regrinding 935 Fl. Regrinding
B	HEAT EXCHANGER GLOBE	BRONZE 106A Sc. Disc Type IRON 612 Sc. Regrinding 613 Fl. Regrinding 141 Sc. Disc Type 142 Fl. Disc Type	BRONZE 750 Sc. Regrinding 950 Sc. Regr.-Renew IRON 918 Sc. Regrinding 919 Fl. Regrinding 774 Sc. Disc Type 775 Fl. Disc Type	BRONZE 801 Sc. Disc Type 1140 Sc. Regrinding 1150 Sc. Regr.-Renew 970 Sc. Regr.-Renew 982 Sc. Regr.-Renew Bolted Bons. IRON 922 Sc. Regrinding 923 Fl. Regrinding 162A Sc. Disc Type 162 Fl. Disc Type
	GATE	BRONZE & IRON Same as "A" above	BRONZE & IRON Same as "A" above	BRONZE & IRON Same as "A" above
C	DRAIN LINES GATE	BRONZE 47 Sc. Travel. Spindle 49 Sc. Travel. Spindle 370 Sc. Non-Rising IRON 325 Sc. Non-Rising 326 Fl. Non-Rising	BRONZE 270 Sc. Non-Rising IRON 251 Sc. Non-Rising 255 Fl. Non-Rising	BRONZE 280 Sc. Non-Rising IRON 203A Sc. Non-Rising 203 Fl. Non-Rising
D	HEADERS GATE	BRONZE & IRON Same as "A" above	BRONZE & IRON Same as "A" above	BRONZE & IRON Same as "A" above
	SWING CHECK	BRONZE & IRON Same as "A" above	BRONZE & IRON Same as "A" above	BRONZE & IRON Same as "A" above
	GLOBE	BRONZE & IRON Same as "A" above	BRONZE & IRON Same as "A" above	BRONZE & IRON Same as "A" above
	HORIZONTAL LIFT CHECK	BRONZE & IRON Same as "A" above	BRONZE & IRON Same as "A" above	BRONZE & IRON Same as "A" above

Motor-operated Iron and Steel Valves can be supplied.

NEXT MONTH—H.P. PROCESS SYSTEMS

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JENKINS BROS., REG. U.S. PAT. OFF. TRADE JENKINS MARK Jenkins Bros BRIDGEPORT, CONN.

Number 106

Safe Loads on Wire-Rope Slings

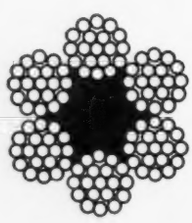
▶ A WIRE-ROPE BRIDLE SLING is usually composed of two single slings or legs fastened together at the top with a ring or link as shown on the left. This ring is put onto the crane hook and when lifting a load the legs are usually spaced at an angle as in the diagrams. Maximum safe loads given in the table for vertical slings and those spread at an angle are for improved-plow-steel, 6x19, hemp-center wire ropes, having breaking strengths given in the second column from the left in the table.

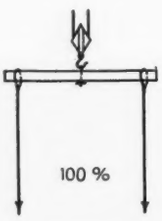
The safe loads listed below are based on a factor of safety of approximately 7 in the rope. These loads may be lifted with slings equipped with spliced-in fittings or that are socketed and do not bend around the load.

For slings with two legs in parallel, the safe loads, column 6, are twice that for a single sling of the same size, column 3. When the slings are used at an angle other than vertical, their safe lifting capacity must be reduced. For example, a pair of 1-in. slings used vertically have a safe lifting capacity of 24,000 lb, column 6. When these slings are used at an angle of 60 deg to horizontal, column 7, they are good for a vertical lift of only 20,800 lb and at 30 deg their vertical lifting capacity is only 12,000 lb.

Safe hoisting depends upon quick judgment in the field of the condition of the rope and the angle of spread.

Data supplied by A. Leschen & Sons Rope Co.





Rope Dia., In.	*Rope Breaking Strength, Lb*	*Vertical Hitch*	*Anchor Hitch*	*Basket Hitch*	*Double Vertical Hitch*	*Double 60-deg Hitch*	*Double 45-deg Hitch*	*Double 30-deg Hitch*
		SAFE LOADING ON WIRE-ROPE SLINGS, LB						
⅜	12,600	1,800	1,500	3,000	3,600	3,100	2,500	1,800
½	21,600	3,100	2,500	5,000	6,200	5,400	4,400	3,100
⅝	33,200	4,250	3,500	7,320	8,500	7,400	6,000	4,250
¾	47,400	6,800	5,600	11,800	13,600	11,800	9,600	6,800
⅞	61,400	9,200	7,600	16,000	18,400	15,900	13,000	9,200
1	81,000	12,000	9,900	20,800	24,000	20,800	16,900	12,000
1⅛	106,000	15,100	12,500	26,400	30,200	26,200	21,400	15,100
1¼	130,000	17,500	14,500	30,800	35,000	30,400	24,700	17,500
1⅜	157,000	21,200	17,500	37,200	42,400	36,700	30,000	21,200
1½	185,000	25,200	20,800	44,200	50,400	43,600	35,600	25,200
1⅝	216,000	29,500	24,300	51,600	59,000	51,100	41,700	29,500
1¾	248,000	34,100	28,300	59,900	68,200	59,100	48,200	34,100
1⅞	281,000	39,100	32,300	68,600	78,200	67,800	55,200	39,100
2	322,000	44,300	36,700	78,000	88,600	76,800	62,100	44,300

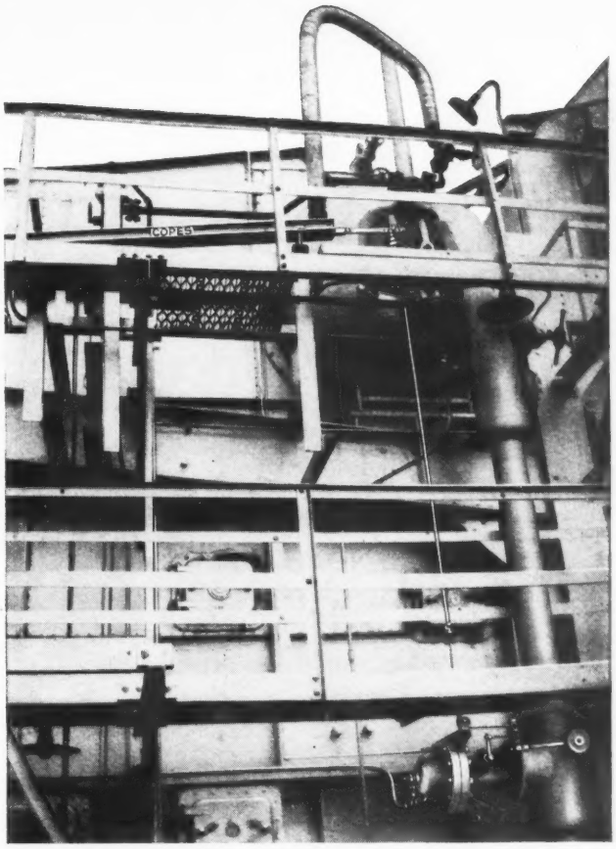
© POWER

★ Why more and more modern boilers are Flowmatic-controlled

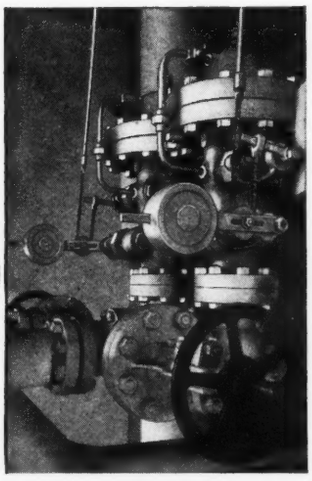
Users of the COPES Flowmatic Regulator will give you many reasons why they are so thoroughly satisfied with this simplified steam-flow type feed water regulator. They will tell of how it has helped get new boilers on the line more quickly, because it gave good feed and level control from the moment it was put into operation. Of how easily it is kept in regular service by no more than routine inspection and care by the plant personnel. Of how closely their boiler water level is held—even on their sharpest load swings—by the two-element COPES Flowmatic.

These are the reasons why more and more modern boilers are being equipped with COPES Flowmatic. These are your reasons for considering COPES Flowmatic for your new boilers. As you can learn from the experience of users in plants like your own, this most-modern feed water regulator gives the results you want—no matter how severe your service requirements. If you would like to check this for yourself, write us for names of installations where you can get first-hand information.

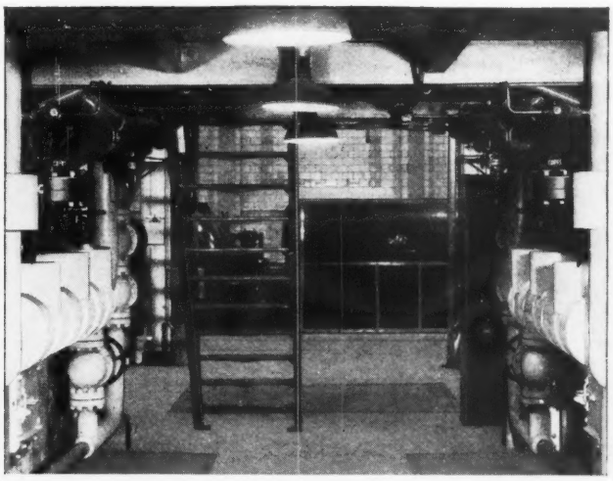
NORTHERN EQUIPMENT COMPANY
511 GROVE DRIVE, ERIE, PA.
Feed Water Regulators, Pump Governors, Differential Valves, Liquid Level Controls, Reducing Valves and Desuperheaters.



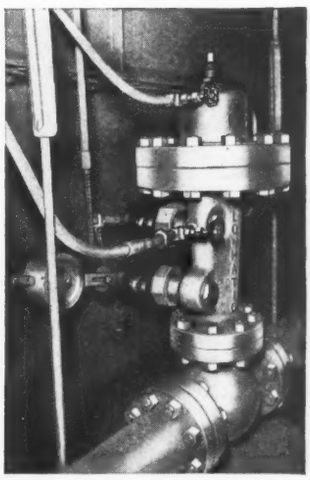
Plant superintendent tells of the excellent results obtained from this all-outdoors COPES Flowmatic Regulator installation on a 450 pound pressure Riley Steam Generator. Write for Bulletin 413.



Master mechanic discusses level control with these Flowmatics on 425-pound Laskers. Bulletin 419.



COPES Flowmatic Regulators on two 650-pound Foster Wheeler boilers in mid-western utility plant. Bulletin 429 gives complete data on Flowmatic design, operation and performance. Write for it.



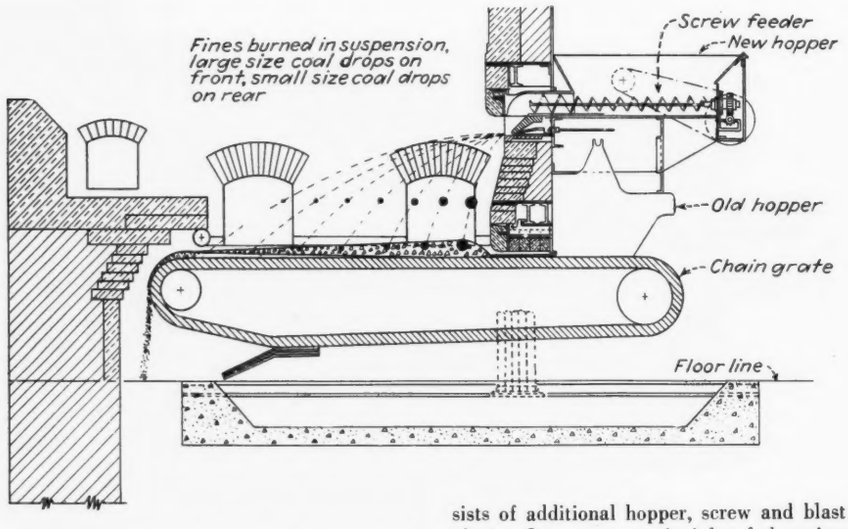
Bulletin 423 is chief engineer's story of Flowmatic control on 155 pound Vogt textile mill boiler.

★ GET CLOSER LEVEL CONTROL WITH THE COPES FLOWMATIC ★ REGULATOR
FEEDS BOILER ACCORDING TO STEAM FLOW•AUTOMATICALLY

WHAT'S NEW IN PLANT EQUIPMENT

Coal Crusher And Sampler (below, left)

STURTEVANT MACHINE CRUSHES 3-in. and smaller coal and coke at rate of 1 ton per hr to approximately 8 mesh and finer with large percentage of 20 mesh and finer, or larger capacities for coarser work. At same time, the unit automatically picks out representative 5, 10 or 15% sample of all coal or coke passed to it. In operation, coal or coke is fed into hopper, where it is gripped by revolving coarse crushing nut and roughly crushed against top crushing liners. It is then passed by gravity to revolving fine-toothed crushing disk and stationary liner, where crushing is finished. This finely crushed material is uniformly discharged at periphery of the rotating disk, where, as desired, 5, 10 or 15% of the circumferential discharge is caught and passed by gravity through the independent small "sample" spout. Balance is passed by gravity to larger inclined spout. Machine furnished for either belt- or motor-drive; motor-driven machine requires a 3-hp motor with which may be used a V-belt or silent-chain drive. The 5, 10, and 15% sample spouts can be easily and quickly changed from outside of machine, and may be attached to either right- or left-hand side of machine. *Sturtevant Mill Co, 171 Clayton St, Boston, Mass.*

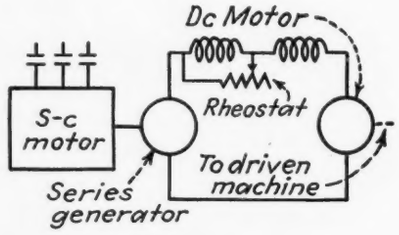

Fines burned in suspension, large size coal drops on front, small size coal drops on rear
Screw feeder
New hopper
Old hopper
Chain grate
Floor line

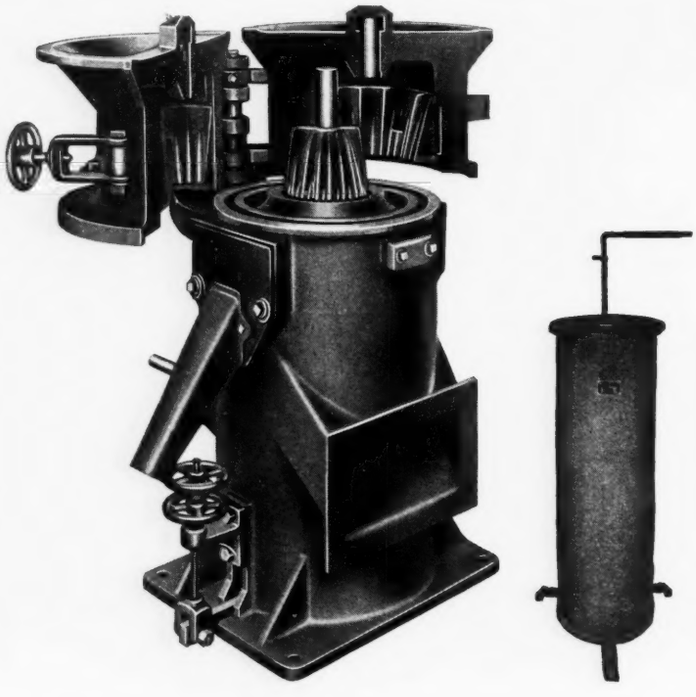
Thermocouple Furnace (center)

CHECKING FURNACE FOR THERMOCOUPLES consists of small electric furnace which provides zone of practically uniform temperature for the intercomparison of laboratory standard couples and for comparison of laboratory standard and plant standard couples. New accessory which increases checking accuracy is cylindrical copper equalizing block that fits inside furnace. Five wells are drilled in this block to hold comparison standard and four couples being checked. With equalizing block, checks can be made within plus or minus 1 deg F; without it, checks can be made within plus or minus 3 deg F over a range of 300 to 1800 F. *Leeds & Northrup Co, 4934 Stenton Ave, Philadelphia, Pa.*

Chain-Grate Stoker (above)

ILLUSTRATION SHOWS APPLICATION of "Fyr-Feeder" spreader stoker in conjunction with regular chain-grate stoker. Equipment consists of additional hopper, screw and blast of air. Operates on principle of dropping various sizes of coal into combustion chamber together, subjecting them to blast, which separates fine from coarse particles. Heavy particles are then dropped directly onto chain-grate bed, while fines are thrown farther, some burning in suspension. Said to provide increased capacity, flexibility, ability to burn cheaper coal, thinner fuel bed and automatic control. *American Coal Burner Co, 155 East Superior St, Chicago, Ill.*

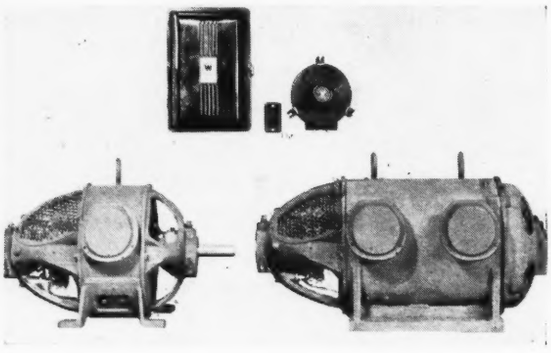




Adjustable-Speed AC Motor Drive

TEN-TO-1 ADJUSTABLE-SPEED drive uses series circuit without usual exciter. Available in ratings from 1 to 15 hp, with standard speed range of from 175 to 1750 rpm, for 2- or 3-phase operation on 220,- 440,- or 550-volt, 60-cycle systems. New drive has five parts, as photo shows, including control. They

(*Continued on page* 150)



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ENGINEERS' BOOKSHELF

Electrical Generation

GENERATING STATIONS (Third Edition, 1941). *By Alfred H Lovell, Professor of Electric Power Engineering, University of Michigan. Published by McGraw-Hill Book Co, Inc, 330 W 42nd St, New York, N. Y. 471 pages, 6½x9 in., 237 illustrations, 28 tables, cloth binding. Price $4.50.*

Since the second edition of this book was published in 1935 there have been many radical developments in the power-generation field. Hydroelectric units and transmission lines of unprecedented capacity have gone into service. Steam pressures up to 2400 lb and temperatures up to 1000 F have been adopted in central stations.

Hydrogen-cooled generators up to 60,000-kw rating, operating at 3600 rpm, are now in service. New designs of oil, oil-poor and oilless high-voltage, high-speed circuit-breakers and high-speed relays have made radical changes in circuit protection and switching practical thought impossible a few years ago. These and other developments have in many ways changed power generation and transmission.

The third edition of this book has been revised and brought up to date by including the new developments in power generation of the last five years. It is divided into 11 chapters: Elementary principles of corporate finance; cost of stations; economic decay; power-plant load curves; economic conductor section — power-distribution systems; power-plant location; bus systems and current-limiting reactors; circuit breakers and their applications; single-phase short-circuits; protective relays and their applications; transmission lines and synchronous condensers. The book should be useful to all engineers interested in the economics and design of central stations.

Fire Protection

CROSBY-FISKE-FORSTER HANDBOOK OF FIRE PROTECTION (Ninth Edition, 1941). *Robert S Moulton, General Editor. Published by the National Fire Protection Association, 60 Batterymarch St, Boston, Mass. 1300 pages. Price $4.50.*

Completely new and up-to-date manual of inspection, maintenance and regulations covers sprinkler systems and other fire-protection equipment. Detailed information on hazards of air-conditioning systems, special types of extinguishing systems, flammable liquids, gases, internal combustion engines, electricity and static charges is included.

As the work of more than 100 leading authorities in the various branches of fire protection, this handbook is an essential part of the reference file of consulting and operating engineers charged with the construction and maintenance of plants where fire hazards are encountered.

Testing Standards

PROCEEDINGS (1940) OF THE AMERICAN SOCIETY FOR TESTING MATERIALS. *Published by the ASTM, 260 Broad St, Philadelphia, Pa. Heavy paper binding. Price $8.50; cloth, $9; half-leather, $10.*

Many important committee reports and appended material presented at the annual meeting of the Society, collected in a single volume of over 1400 pages, offer valuable data and information on the properties and tests of engineering materials. Nine reports pertain to ferrous metals and alloys, seven to non-ferrous. Others cover creep resistance, non-metallics such as concrete mortars, paints, lubricants, fuels, timber, textiles, etc.

Romance of Electricity

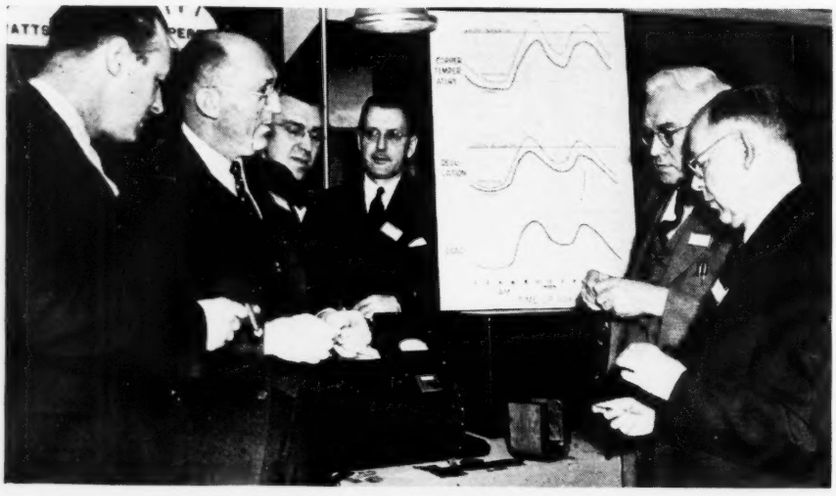
MEN AND VOLTS (1941). *By John Winthrop Hammond. Published by J B Lippincott Co, East Washington Square, Philadelphia, Pa. 436 pages, 6x9 in., illustrated, cloth binding. Price $2.50.*

Sixty-four years ago Philadelphia was preparing for the Centennial Exposition of 1876, street cars were pulled by horses, gas and oil lamps feebly lighted homes and streets because electric power generation and the equipment for using it were still only visions in the brains of a few practical dreamers of that period. It is here that this book begins with Charles Francis Brush who invented the arc lamp and dynamo in 1876 and Thomas Alva Edison who gave the world the carbon-filament lamp in 1879 and ends with Charles P Steinmetz and the lightning generator in 1922.

Written as the history of the General Electric Company, this book is nevertheless the story of the lives of scientists, engineers and business men who contributed so abundantly toward making the present electrical era pos-

(*Continued on page* 142)

INVESTIGATING A NEW TRANSFORMER STEEL



From left to right, Ivan A Given, associate editor, *Coal Age;* H V Putnam, manager, and C C Hortsman, engineer, Westinghouse transformer division; William Jones, sales manager, Armco; and F A Annett, associate editor, POWER, listening to L W Chubb, director, Westinghouse Research laboratories, who is explaining how Hipersil, an improved magnetic steel used in transformer cores, reduces the size and weight of distribution transformers 20 to 25% and copper losses 10%. This new steel has one-third greater magnetic-flux-carrying capacity than the best conventional silicon steel and is a product of joint research by Westinghouse Electric & Mfg Co, and the American Rolling Mills Co

SEAMLESS-SMOOTH SURFACES!
NON-RUST FOR LONG SERVICE!
ANACONDA TYPE K
IT ALL COMES DOWN TO THIS!
COST?—LITTLE MORE THAN RUSTABLE PIPING!

Rustproof Anaconda Copper Tubes mean *Money Saved* in your plant—

PIPE-EATING RUST is also a profit-eater. For every time a pipe clogs or rusts through, you lay out money for repairs—and perhaps write off some down-time too.

Copper Tubes end all that because they're absolutely rustproof. Further, their installed cost in smaller sizes is scarcely more than that of rustable piping; and, with larger sizes, space savings due to compact fittings often more than save the higher material cost.

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THE AMERICAN BRASS COMPANY, General Offices: WATERBURY, CONN.

In Canada: Anaconda American Brass Ltd., New Toronto, Ont. • Subsidiary of Anaconda Copper Mining Company

Steady, Boys! . . .

TOUGH TOP SERGEANTS always said, "Forrud, H-A-A-ARCH!" to the doughboys, and they'd step right out. But you couldn't start a horse-drawn artillery outfit that way. Instead, the command was, "Foh-wahd . . . Hah -O-O-O-Oh!", long and singsongy, to give the 6-horse teams a chance to settle into their collars. When the green officer tried foot-soldier commands, the horses bucked, reared and plunged, wrecking a lot of harness—but got exactly nowhere. The willing horses tried to hit their collars, while the laggards hung back in their breechings—and in twenty seconds that artillery outfit could tie itself into fancier knots than any sailor ever saw. After a period of such training with incompetent commanders, it practically took a rest cure to build those horses back into tractable animals again.

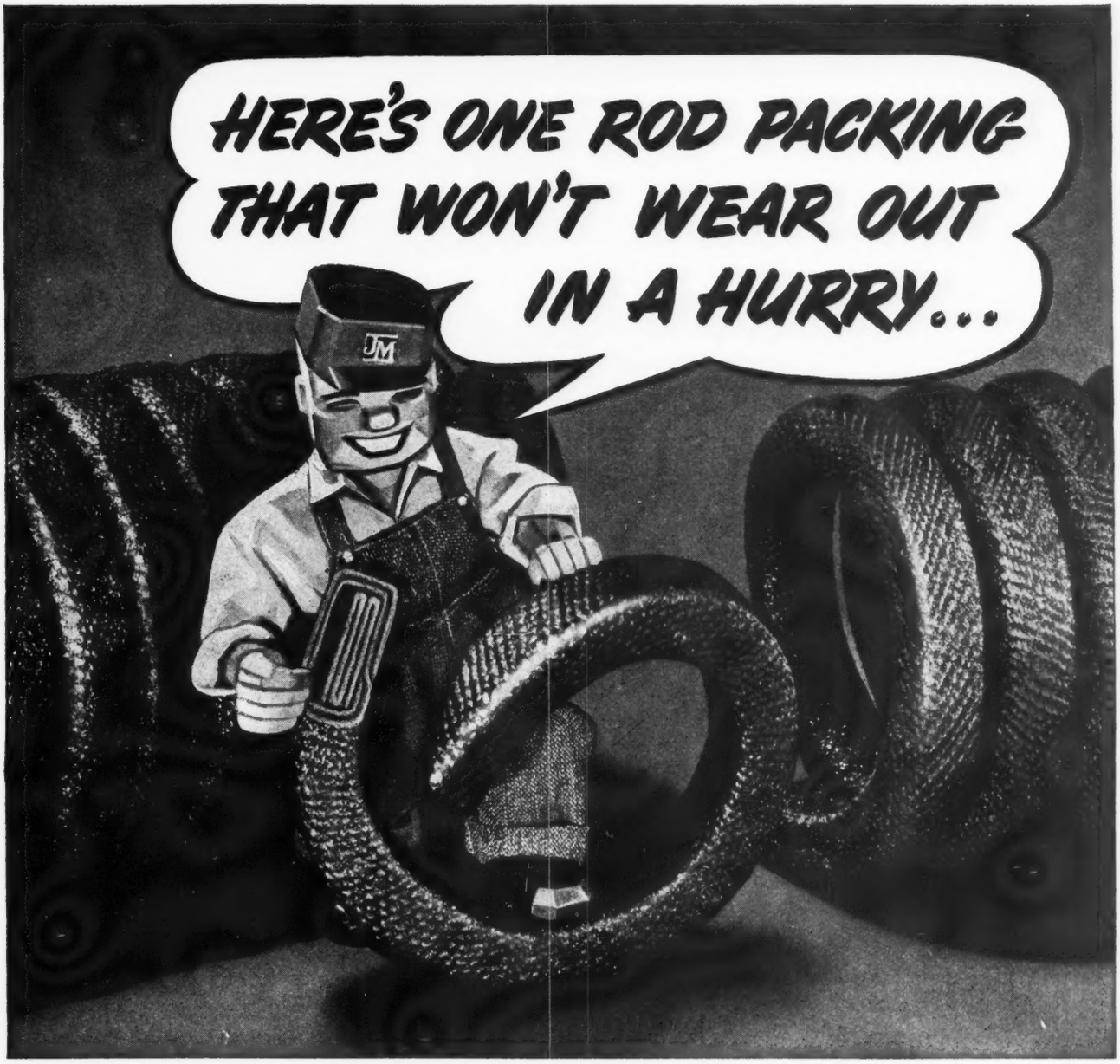
The stock-market crash a dozen years ago was like that first wrong command. A continuing series of "emergencies" since then, some economic and some political, have developed a first-class case of jitters in all of us. Recent events, abroad and at home, haven't helped settle our jangled nerves any. The newspapers and the radio shout scareheads at us. Extremely militant, but safely over-age, Don Quixotes are dashing about tilting at windmills. Every society dame has her pet relief project. Every politician is sure he knows the only safe way to save America. This driver pulls us left, that one right. And back of it all is the continually increasing flood of propaganda—for capital or for labor, for intervention or for isolation, or just against everything—all fed by "smart" money attempting to fan a first-class flame of hysteria.

I think we're needing a lot of that slow, steady commanding right now—both as individuals and as a nation. That's the only way we can settle into our respective collars to pull together at the job we've got to do—and that's the only way we'll get the job done.

Meanwhile, us little fellows can help our own nerves a lot by remembering that old artillery command, or its farm counterpart, "Steady now, boys, hit it AW-W-WL TOGETHER!"

George Edwards
Engineer

***Mankind is a weaver who, from the wrong side, works on the carpet of time. Through the centuries of weaving, he sees nothing but a tangle of strings. The day will come when he will see the right side, and understand the grandeur he, with his own hands, has woven.*—LAMARTINE.**



J-M KEARSARGE LASTS LONGER... CUTS RE-PACKING COSTS

For continued efficient service against high-pressure steam, you can't beat this rugged rod and plunger packing.

Its unique folded construction provides natural resiliency and forms a reservoir for the preserving lubricant, keeping the packing pliable in service. Additional resiliency is provided by a red rubber expansion back in the center block. And resistance to wear is assured by a double wrapping of asbestos cloth.

You can use Kearsarge Rod Packing, together with other packings and gaskets in the complete Johns-Manville line, to minimize equipment shutdowns . . . save much of the expense and loss of production caused by too-frequent *re*-packing. For details, ask for the new J-M Packing Catalog. Johns-Manville, 22 East 40th St., New York, N. Y.

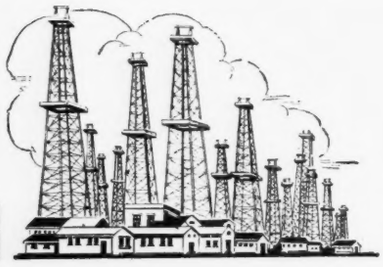
JM PRODUCTS

Johns-Manville PACKINGS & GASKETS

THERE'S A DISTRIBUTOR NEAR YOU

★ THERE'S A BELMONT PACKING FOR EVERY SERVICE ★

FOR OIL



NOW, when every production minute has an increased value, no plant can afford to have unnecessary delays and equipment failures caused by inadequate packings. That's why it is important to pack with Belmont—the packings that are pre-planned for service.

Below are two of the many Belmont Packings especially made for Oil Services, packings that will perform their tasks faithfully—even under the strain of 24-hour-day operations. Both Belmont 6100 and 189 are made from selected high grade asbestos yarn, braided, and treated with an exclusive lubricant for ultimate wear and greater efficiency.

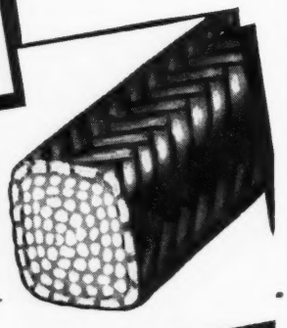
The complete line of Belmont Packings (for all types of services) is illustrated and described in detail in Belmont Catalog No. 40. Write for a FREE copy on your company letterhead today! Any Belmont distributor will be glad to show you samples and help you with your particular packing requirements.

BELMONT PACKINGS

THE BELMONT PACKING & RUBBER CO. — BELMONT — PHILADELPHIA, U.S.A.

FOR GASOLINE SERVICE
BELMONT 6100

For rod and valve stems handling volatile distillates such as gasoline, kerosene, naphtha, and benzol.



FOR HOT OIL SERVICE
BELMONT 189

For rods and plungers handling hot or cold oil—all temperatures.

THE BELMONT PACKING & RUBBER COMPANY
BUTLER AND SEPVIVA STREETS • PHILADELPHIA, PA.

★ ★

Conveyor Belts

(*Continued from page* 93)

bly mounted idlers have been known to rise up out of their fastenings and operate that way until the belt was injured. Again, return idlers have worked along their shafts, allowing the belt to sag several inches over one end, forcing it out of line and causing its edge to rub onto a side rail until the belt was damaged.

Other causes of belts not running true are: misalignment of idlers; unequal loading; bad alignment of supports; one edge of the belt worn, permitting it to stretch more than the other. On the other hand, under very moist conditions, the exposed fabric on the worn edge may absorb moisture and shrink. Not cutting the ends of the belt square before connecting them together is another common cause of crooked-running belts. Whatever the cause, it should be located and corrected, because a large percentage of premature belt failures are traceable to crooked running.

Do not let material accumulate anywhere along the conveyor. Not infrequently, material handled by the conveyor collects in places where it rubs on the belt and causes serious damage. In other instances it has prevented idlers turning, with disastrous results to the belt.

Too Much Tension

Excessive tension in a conveyor belt makes it doubly susceptible to wear and injury. Common causes of excessive tension are over-tightening by takeup screws or weights; increased friction of idlers due to lack of proper lubrication or other causes; overloading inclined conveyors; excessive shrinkage of belt due to constant exposure to moisture; and excessive crown on the head pulley.

Lagging may be applied to the head pulley to increase the coefficient of friction between it and the belt. This permits operating at less belt tension and still gives satisfactory performance. A snub pulley to increase the belt wrap around the head pulley, Fig. 6, will produce the same results as the lagging, but it puts a reverse bend in the belt. The remedies for the other causes are obvious. The take-up should put only enough tension in the belt to keep it from slipping. If the belt surface becomes hard and glazed it can be softened by a mild application of castor oil or of a dressing recommended for rubber belts.

The use of inexpensive portable electric vulcanizers, for repairing cover breaks and preventing the entrance of

Signed: on the dotted line

YOUR GUARANTEE FOR BETTER VALVE PERFORMANCE

AVAILABLE
in these Alloys

Carbon Steel — Carbon Molybdenum Steel— Chrome Nickel Steel— Chrome Molybdenum Steel — Nickel Steel — all poured into castings under the direct supervision of Chapman metallurgists, *right in Chapman's own foundry.*

•

When you see the name CHAPMAN on the body of a valve you're sure of certain facts. You know that the metal has been tested and poured in Chapman's own foundry—under direct supervision of Chapman metallurgists. You know that each part is machined to precise standards by men of leading caliber. You're sure that after passing Chapman's rigid tests, the valve will meet your requirements.

Gate, glove, check and angle valves—valves for temperatures to 1000° and pressures to 2500 lbs.—valves with manual or motor operation—all are available from CHAPMAN. Specify CHAPMAN all the way. No valves will give you more.

The CHAPMAN VALVE
MANUFACTURING COMPANY
INDIAN ORCHARD, MASSACHUSETTS

WELDOLETS · THREDOLETS
TRADE MARKS - REG. U. S. PAT. OFF.
. . . Welded Outlets for Piping . . .

Lifetime Leak-proof Branch "Take-offs" for High Pressure Piping Systems

BONNEY WeldOlets and ThredOlets are the most efficient, most economical and most satisfactory method of providing branch "take-offs" in high pressure systems.

Recommended for all types of piping installations for pressure values equal to those of seamless steel pipe listed for 400 lbs. steam pressure or 1000 lbs. hydraulic pressure with temperatures to 750° F., they have been used to provide branch outlets in a 600 lb., 300° water line; on a 2500 lb. helium piping system; on CO_2 refrigeration piping at 1200 lbs. which was tested in excess of 2500 lbs. Test sections including WeldOlets and ThredOlets have been stressed to 6000 lbs. without failure.

They eliminate all cutting and forming of the main pipe and branch and no templets are needed. They provide absolutely leak-proof junctions, which because of their patented design, are of full pipe strength and reduce turbulence and friction to a minimum.

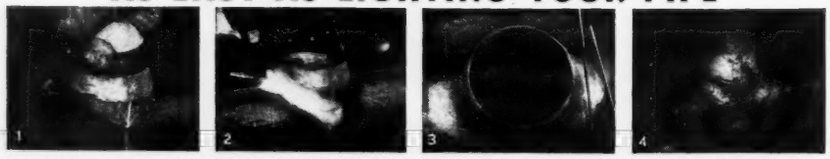
For increased safety and efficiency in your next piping installation get the facts today on WeldOlets and ThredOlets. Write for Bulletin WT29.

WeldOlet

ThredOlet

Socket-End WeldOlet

AS EASY AS LIGHTING YOUR PIPE



(1)—Select the position of the outlet, rub the fitting over the pipe several times to remove scale, mark center lines and tack the WeldOlet or ThredOlet into position. (2)—The fitting is then welded into place by the electric-arc or oxy-acetylene method. A junction of full pipe strength and a leak-proof outlet is the result. (3)—Where the outlet is 2" or larger, the button should be removed after the welding operation. On small sizes the fitting is used as a templet and the hole is cut in the main pipe first, either with a hole saw, the torch or by drilling. Inspection of the inside of the joint is possible by using WeldOlets and ThredOlets, allowing removal of all scale, welding metal, etc. (4)—The branch line is then welded into position. In the event a ThredOlet is used the branch pipe is threaded and screwed into place.

BONNEY FORGE & TOOL WORKS
Forged Fittings Division - Allentown, Pa.
Forged by the Makers of
BONNEY TOOLS
The Finest that Money Can Buy

dirt and moisture into the carcass, is highly recommended and widely accepted. This is a simple process and more and more operators are coming to realize that frequent inspection and an organized system of repair work will result in savings far greater than the cost.

All the factors that influence conveyor belt life have not been covered in the foregoing. Those discussed, however, show the necessity for vigilance and judgment in the care and operation of conveyors. Furthermore, good maintenance pays big dividends in reduced operating cost, increased belt life and greater material-handling capacity.

Turbine-Oil Test

(Continued from page 67)

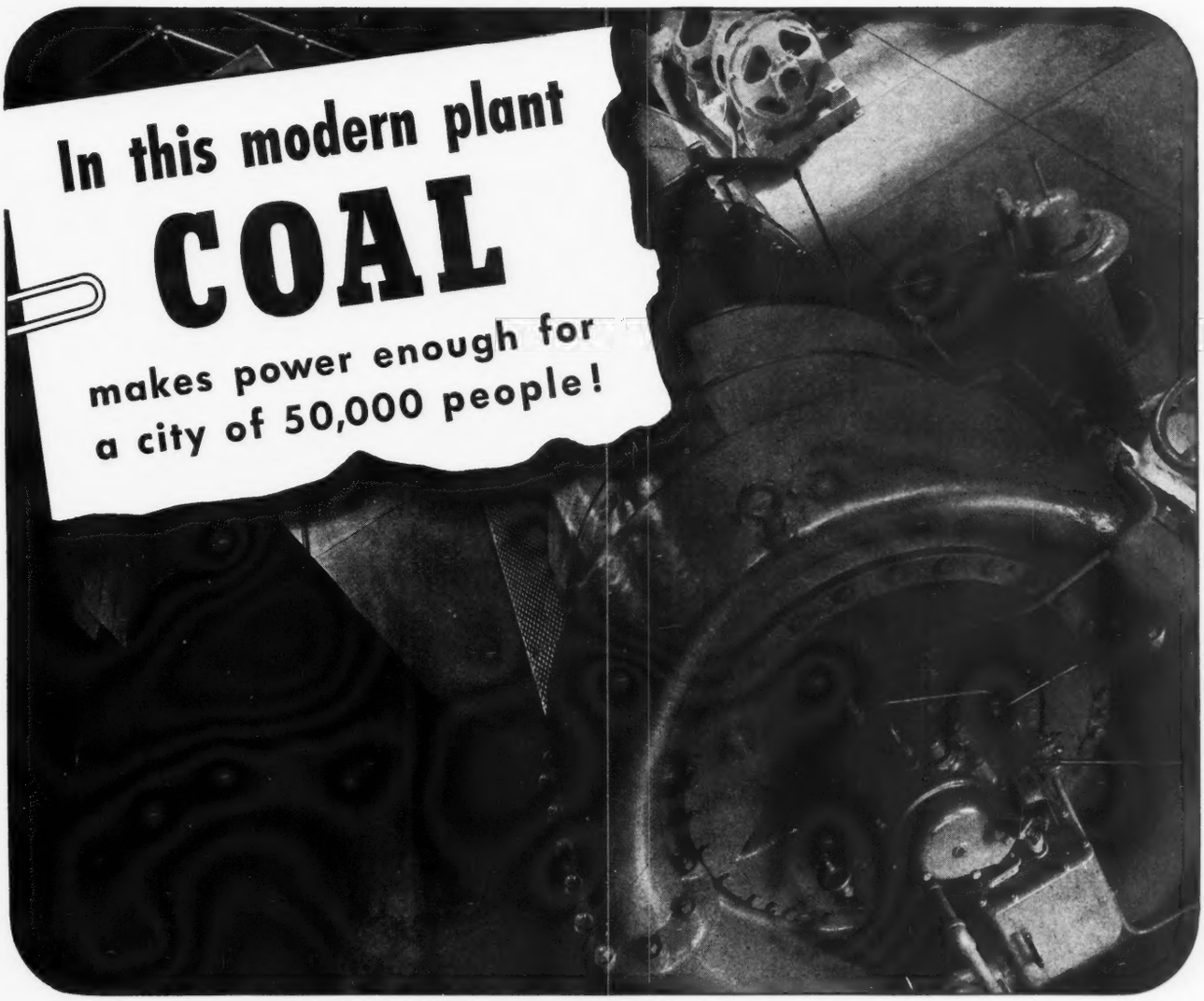
ice hours and required 5 gal of make-up. The neutral number was 0.50 when the bearing failed. A gelatinous coating had formed on the oil strainer and the oil lines. The unit was in service about 40% of the elapsed time.

The second batch of oil *F* had 470 service hours and required 5 gal of make-up. The oil was removed when the neutral number was 0.46 because a gelatinous coating was forming on the strainer. The unit was in service about 15% of the elapsed time.

Oil *G* belongs to the group in which the oil is discarded when the neutral number reaches 0.15. The first batch at 1762 service hours had a neutral number of 0.18. 23 gal of make-up had been added. When removed, the oil contained a trace of sludge, was darker than when it was first placed in the system, but otherwise appeared satisfactory. The unit was in service about 50% of the elapsed time.

Before the second batch of oil *G* was placed in service, the unit was checked to stop oil leaks, after which the following results were obtained. At 1250 service hours the neutral number was 0.08. A few days later the operators reported an acrid odor coming from the oil in this unit. A sample was secured, and the analysis showed a neutral number of 17.4. Ten gallons of make-up had been added to the system. The total number of service hours received by this oil was 1384. The unit had been in operation approximately 50% of the elapsed time. The only difference between the two batches of oil was that the first batch had 23 gal of make-up. while the second had 10 gal.

The Research Department of the refiner of the *G* oil states that their anti-oxidant is of no value when added to



East Walpole, Mass., plant of BIRD & SON, inc., manufacturers of roofing and floor coverings and allied products.

BIRD & SON, inc., with offices and plants at East Walpole and Norwood, Mass., New York, N. Y., Chicago, Ill., Shreveport, La. and Phillipsdale, R. I. have been making quality roofing, floor covering and allied products since 1795. In a year they turn out enough floor covering to reach halfway 'round the world . . . enough roofing materials to circle the globe twice . . . and 9,000,000 quarts of paint for use in their products. An operation as big as this requires dependable power in huge quantity. They get it from economical, modern COAL—using about 100,000 tons a year to generate their process steam and enough electrical power to supply a city of 50,000 people.

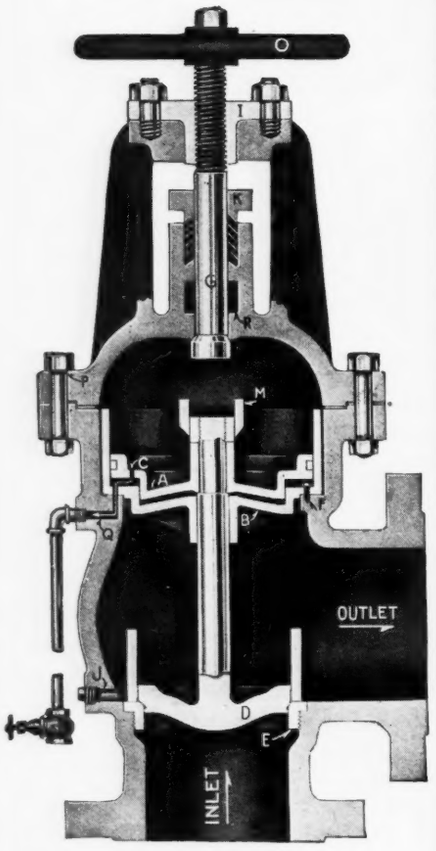
CALL IN A POWER EXPERT

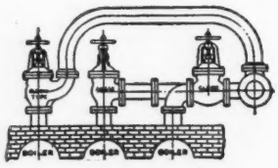
Your plant is different? Certainly! But there are hundreds of ways in which *coal*, the modern fuel, can be used to increase boiler efficiencies, reduce maintenance and fuel costs. Why not let our Fuel Service Engineers study *your* present setup, confer with your engineers, and make suggestions for getting *more* power at lower cost. This service is entirely without obligation or charge. Shall we send a man? Write GEORGE H. REINBRECHT, Coal Traffic Manager, Chesapeake and Ohio Lines, 2901 Terminal Tower, Cleveland, Ohio.

IT PAY$ TO U$E MODERN . . .

Chesapeake and Ohio Lines

Golden Anderson
SPECIALTY
VALVES





NON-RETURN

• A tube bursting in one boiler means that the contents of every boiler in that battery are coming through that rupture *unless* there's a good non-return valve to stop it. To guard against such destruction, install an efficient, non-return valve that *will not* and *cannot* stick—such as the G-A non-return valve shown here. As far as we know, none of the many thousands in use has ever failed.

Safeguard the most valuable thing in the world—human life—with these G-A non-return valves.

WRITE TODAY
FOR FREE CATALOG

also

Altitude Control . . .
Pressure Reducing . . .
Throttle and Emergency Stop . . . Check Valves etc.

GOLDEN-ANDERSON VALVE SPECIALTY CO.
FULTON BLDG. PITTSBURGH, PA.

old oil not containing an anti-oxidant. So, it may be possible that the anti-oxidant had been consumed between make-up periods, and instead of retarding oxidation, the resulting compounds accelerated oxidation. The experience with this oil plainly shows the need of a test to replace the neutral-number test.

The data that are obtained from the tests being conducted on oil in service in this small unit have been of great value in solving problems in other units over the West Penn System, as well as giving a true and accurate picture of what can be expected from the oils in normal service.

Severe corrosion in the oil system was experienced in the 50,000-kw, 3,600-rpm high-pressure unit at Springdale shortly after it was placed in service. Laboratory experiments made with the oil in this unit and by the test previously described showed that the addition of 10% of used oil (oil of the same stock and containing some anti-oxidant) would prevent corrosion in the presence of 2% water by volume. Based on these experiments, 10% of the used oil was added to the system. Before this addition all loose corrosion products were removed. Since then no corrosion has been found on any of the metal exposed to the oil at the time of the first water contamination following addition of the used oil. The unit was operated for one period of three weeks with 3% of water in the system and 50 gal of water per hour were removed by centrifuge and no corrosion occurred.

Two Theories

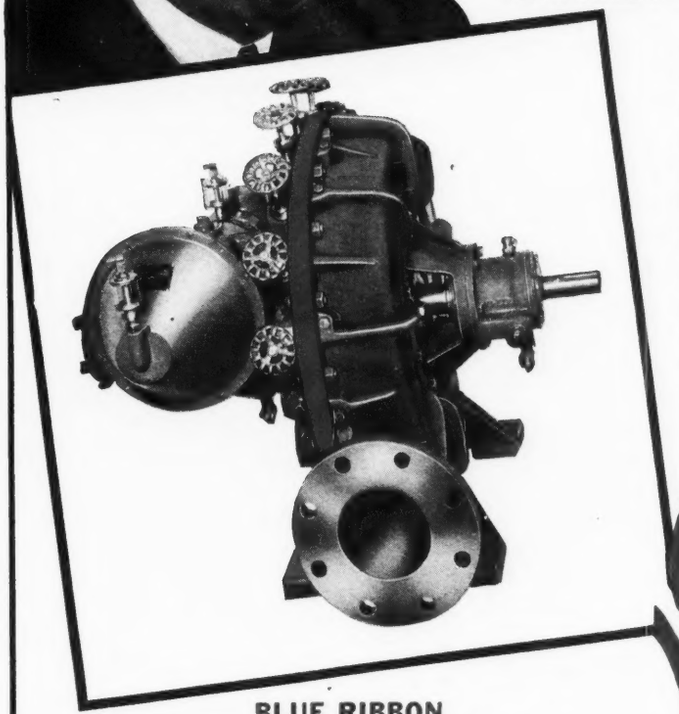
Two theories have been offered to explain why the addition of the used oil to the oil already in the system prevented further corrosion—increased wetting characteristics of the oil, or removal of some compound from the oil that deposited a minute film on the metal surface that made the metal passive. Wilson, Von Fuchs and Edlund[3] refer to the wetting properties of an oil for corrosion prevention. The theory has been advanced by Dantsizen[4] that corrosion inhibition is produced by the water soluble or hydrophilic part of an organic acid molecule that attaches itself to the iron surfaces. After a layer of such molecules has attached itself to the iron, the oil soluble or hydrophobic part of the molecule repels the water and inhibits the rusting of iron.

Operating experience is partly in accord with the theory advanced by Mr. Dentsizen, but the results indicate that protection once made is more permanent than he predicts. It appears that the first water contamination completely removes some compound from

"I CAN'T TELL WHETHER IT'S RUNNING UNLESS I PLACE MY HAND ON THE SHAFT"

Says **PUBLIC UTILITY EXECUTIVE, OF COPPUS-TURBINE-EQUIPPED PUMP**

ANOTHER COPPUS BLUE RIBBON PRODUCT



A prominent pump manufacturer says that "numerous unsolicited testimonial letters, have come in from customers, praising the performance of this machine," a pump equipped with the Coppus Blue Ribbon Steam Turbine. One of the testimonials received by the pump manufacturer, is quoted in the caption above.

Such sweet-running, trouble-free performance is one of the main reasons why men like pumps to be equipped with Blue Ribbon Steam Turbines. The other reason is the economy of buying turbine equipment sized right for small jobs.

BLUE RIBBON INDICATES THESE ADVANTAGES

On all Coppus Products, the Blue Ribbon is a seal of precision and careful inspection. In the case of Steam Turbines, it means:

(1) Precision workmanship — controlled by Johansson size blocks
(2) Encased governor — slow speed, leverless
(3) Separate safety trip—pilot-operated, leverless
(4) Partial load economy — by individual nozzle control
(5) Dynamometer tested — before shipment

87% repeat orders, out of our 1939 Steam Turbine business. Operated by steam, gas, or air. Built-in speed reducers available. Vertical or horizontal types.

Write for full facts in free bulletin 135-9

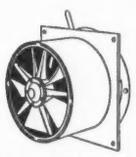
H. P. not E. P.* for Small H. P. jobs

*Elephant Power — a large-size turbine for a job a small-size Coppus could handle. Save investment cost with a Coppus Turbine sized close to your needs.

Coppus Engineering Corp., 359 Park Avenue, Worcester, Massachusetts. Sales offices in THOMAS' REGISTER. See SWEETS' CATALOG for other "Blue Ribbon" products—air filters, gas burners, blowers, ventilators, fans.

COPPUS BLUE RIBBON PRODUCTS

Designed for your Industry
Engineered for You



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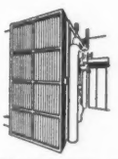

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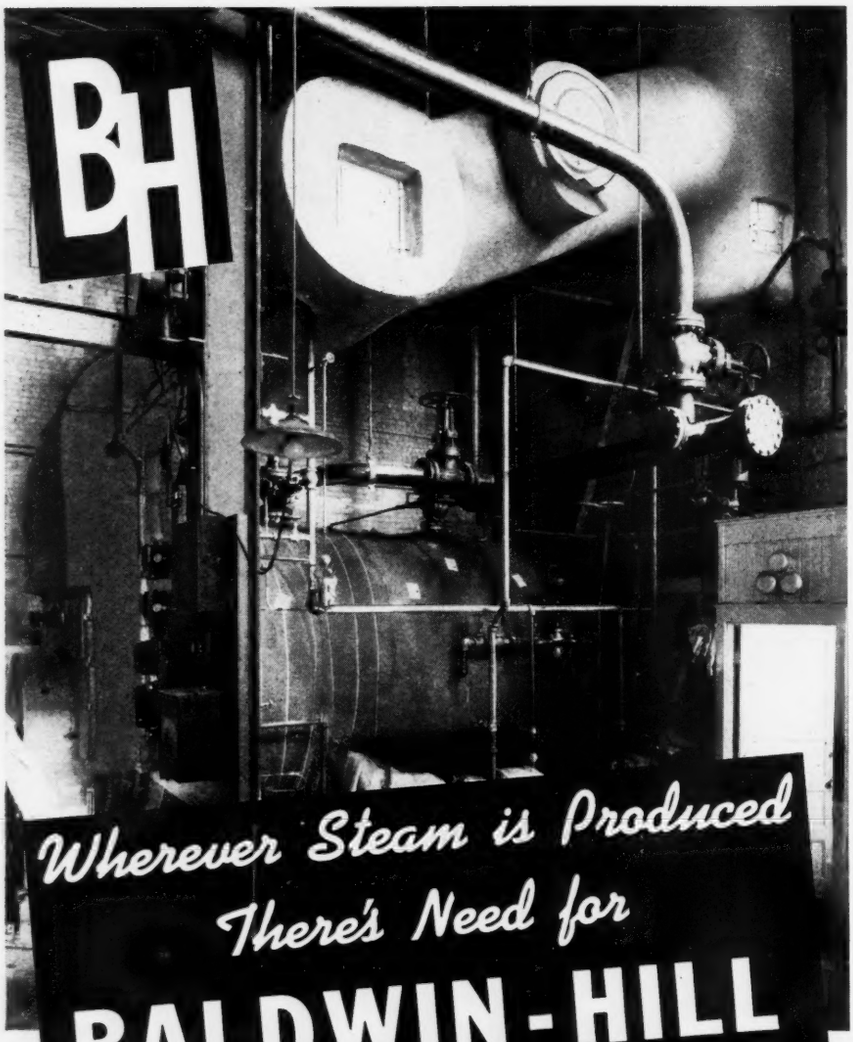
COPPUS



Wherever Steam is Produced There's Need for

BALDWIN-HILL Heat Insulation

Scotch Marine Boiler & Breeching
Job in progress above shows a Scotch Marine Boiler being insulated with B-H Black Rockwool Blanket while on Breeching Blanket has been applied and covered with B-H No. 1 Insulating Cement.

Send for Catalog
showing complete line B-H Black Rockwool Blanket . . . B-H No. 1 Insulating Cement . . . B-H No. 100 Pipe covering . . . B-H Mono-Block . . . B-H Weatherseal . . . B-H Bond-Tite and other insulating materials effective up to 2000° F.

Present power requirements have reached an all time high. Plants are cramming all possible output from present facilities while new equipment is being installed to handle future demands.

To operate at maximum efficiency . . . to eliminate waste of heat and power . . . to reduce the cost of producing that additional power, Baldwin-Hill offers a complete line of insulation materials with a type to meet every condition of service—particularly where high temperatures and excessive moisture are encountered. For any problem in stepping up the efficiency of your hot equipment call in a Baldwin-Hill engineer. He'll fit the insulation to your particular job.

BALDWIN-HILL CO., 575 Klagg Avenue, TRENTON, N. J.
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Reduce Heat Losses with **BALDWIN-HILL** B&H *High Efficiency* **INSULATIONS**

the oil and deposits a very minute film on the surface of the metal that prevents corrosion. Metal changes made in the oil system after this film is deposited are not inhibited against corrosion. Test strips that were in the circulating oil system when the first water entered after the addition of used oil did not corrode; but any portion of the strip that was polished later corroded in the presence of water, while the unpolished area did not change. Laboratory tests confirmed these results.

New anti-rust compounds are constantly entering the market, and while some of the later ones have not been tested, none that were tested up to eight months ago would completely inhibit corrosion after the oil had been washed several times with distilled water.

Addition of Old Oil

Wilson, Von Fuchs and Edlund[3] report laboratory tests which showed that the addition of old oil to new oil might lower its life to 20% of the expectancy if the old oil had not been added. Results obtained in service are in accord with this statement under the following conditions: When the old oil added had a high neutral number, was not originally inhibited, or when the anti-oxidant had been completely exhausted. Their laboratory tests also help to explain why the addition of an inhibited oil as make-up to old uninhibited oil in a system does not prolong its life, in fact, sometimes apparently shortens the expected life. The reaction between the anti-oxidant and the oxidized compounds in the old oil may destroy any value that it possessed.

When used oil containing an anti-oxidant is added to new oil containing an anti-oxidant, the life of the new oil does not appear to be materially affected by the addition. The results on the unit that had severe corrosion, and in which the used oil added contained some anti-oxidant, after 20,000 service hours with the normal amount of make-up show no indication of break-down of the oil.

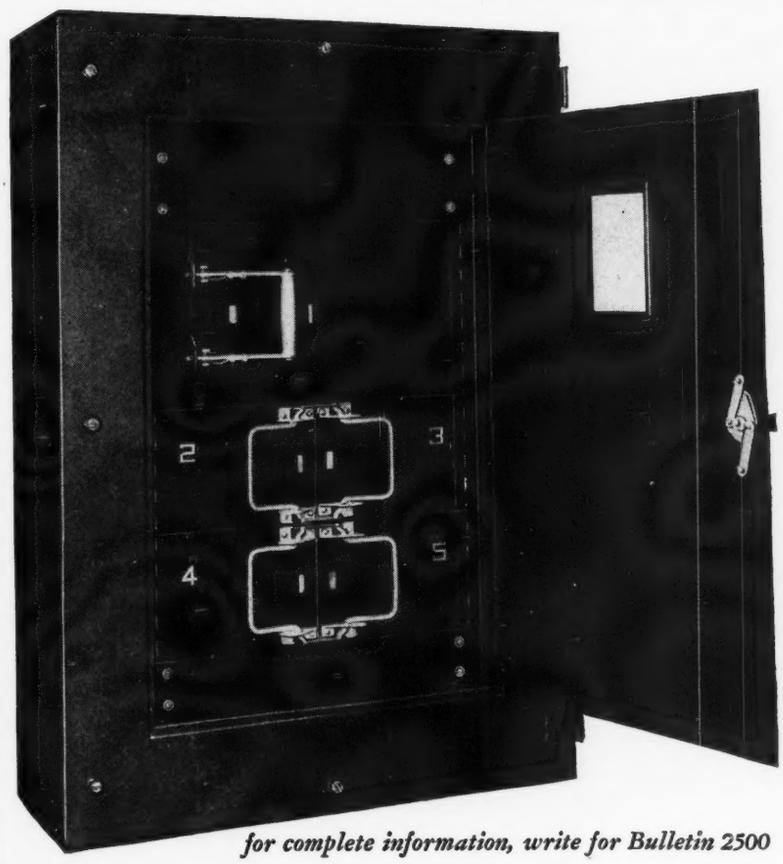
Credit must be given to the refiners of turbine oils for the better product that can now be purchased. For future progress cooperation between the refiners and the users is to be encouraged. This article is written only with the thought of reviewing past events and looking optimistically toward the future.

WHAT THE NEMA WILL DO IN 1941. *National Electric Manufacturers Association, 155 East 44th St, New York, N. Y. No price listed.*—Describes 69 projects which constitute the activities and services of the Association for 1941 as approved by the membership.

SQUARE D

Saflex DISTRIBUTION PANELBOARDS

FOR SAFETY AND FLEXIBILITY IN CONTROLLING ELECTRIC SERVICE AND FEEDERS SUPPLYING CURRENT FOR POWER, HEAT AND LIGHT



for complete information, write for Bulletin 2500

Saflex units are safe to operate. No live parts are exposed and all circuits may be opened safely under maximum load. The double break switch jaws are visible for inspection when the unit door is open. The switch blade assembly is the only part carried on the permanently anchored door. All poles are broken simultaneously with no possibility of causing single phasing. Rotary switch blades are provided on all units except 600 ampere size. The cabinet doors are equipped with Yale cylinder locks which prevent unauthorized access to the panel. The box has over-size wiring gutters.

The interior, front and box are separate units. Thus, the box can be shipped alone and roughed-in during the early stages of construction, with the interior and front following at a later date.

Today, when speedy delivery is often a vital factor, it is important to know that Saflex panelboards can be furnished promptly.

Built to "Take It"!

The exceptional simplicity and sturdiness of design and construction of Saflex switch units is shown in the lower illustration. These units, ranging from 30 to 600 amperes, are for use in systems up to 575 volts A. C. or 250 volts D. C.

A The switch unit door can be locked in either the ON or OFF position by means of a padlock on the bracket.

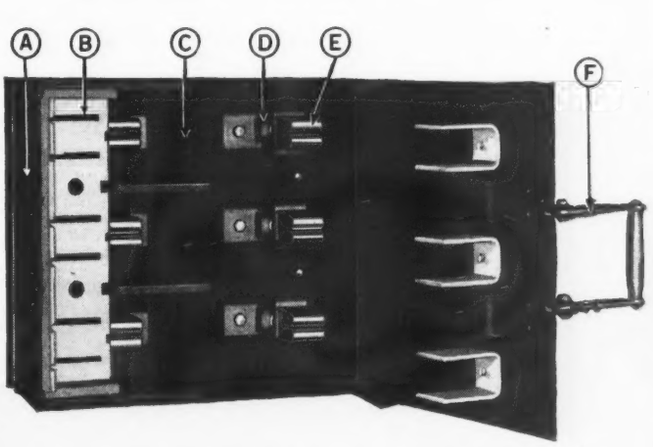
B Arc suppressor block greatly increases the rupturing capacity.

C Shatter-proof insulating base is mounted in steel box for maximum mechanical protection. No molded parts are exposed when door is closed.

D Solder-solderless lugs can be used either as solderless connectors or as solder lugs or both. They are furnished on all units except 30 ampere, 250 volt units.

E Positive pressure fuse clips have high conductivity and assure automatic contact pressure at the fuse terminals without auxiliary parts. This important feature eliminates clamping screws or parts which might not be sufficiently tightened or which might become loose due to vibration or temperature variation.

F Cam-action is provided by handles near switch jaws where it is most needed. This cam-action supplies (with minimum manual effort) the considerable force necessary to provide high contact pressure.



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SQUARE D COMPANY

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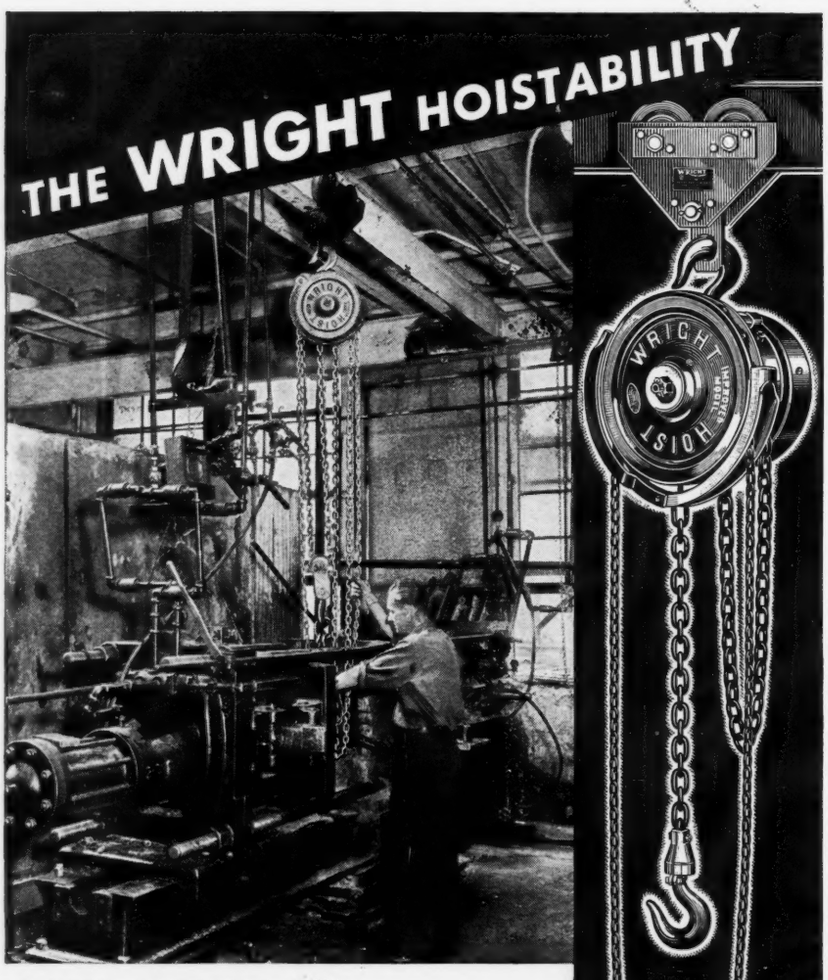

WRIGHT *Improved High Speed* **HOISTS**

HAVE "HOISTABILITY" which means vertical transportation with *speed, economy* and *safety*.

Every WRIGHT *Improved High Speed* HOIST is *fast,* smooth and positive in action—because of Wright precision load wheel and driving spindle bearings. It is *economical,* being highly resistant to corrosion because of its full zinc coating.

It is *safe* with a load chain that stays in the pocket, regardless of operating position—because of the Wright safety guard.

Furthermore, the load chain has a safety factor of 7 to 1, and is made of a special process steel which permits it to elongate (under overload) 3″ to the foot before breaking. Likewise the bottom hook will slowly open so that anyone can see the danger when loaded beyond the elastic limit of the chain.

WRIGHT TROLLEYS are as dependable as Wright Hoists—made to give long, faultless service. . . . Write for the WRIGHT CATALOG describing modern hoisting equipment in capacities from ¼ to 50 tons.

WRIGHT MANUFACTURING DIVISION
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Engineers' Books

(*Continued from page* 130)

sible. The work is divided into eight parts: The creative period of the arc and the incandescent lamps; period of commercial introduction of electric lighting; electric transportation, motors, the transmission of power; period of expansion and consolidation; formation of the General Electric Company; development of big generating units, beginning of hydro-electric projects, expansion of systems through transmission; development of the steam turbine, start of industrial research and of commercial and financial expansion; spectacular applications and discoveries, continued expansion, birth of radio, major achievements—marking the end of the pioneer period. This book is a distinctive contribution to the history of electric power generation, transmission and application presented in a very readable manner.

Thermodynamics

THERMODYNAMICS (Second Edition, 1941). *By H A Everett, head of the Department of Mechanical Engineering, Pennsylvania State College. Published by D Van Nostrand Co, 250 4th Ave, New York, N. Y. 466 pages, 6x9 in., illustrations and charts. Price $3.75.*

Primarily intended as a text for engineering students, this revision of the original fundamental exposition of thermoydynamic principles takes account of the new spectroscopic data of the specific heats of gases at high temperature, with emphasis on the continuous-flow principle as applied to heat engines. A revised approach to the problems of fluid flow brings the original up to date.

Chapter headings include the energy and mechanical theory of heat, mechanical theory applied to gases, engines, fluids, vapors, refrigeration. The order and treatment of subject matter closely follows classroom presentation.

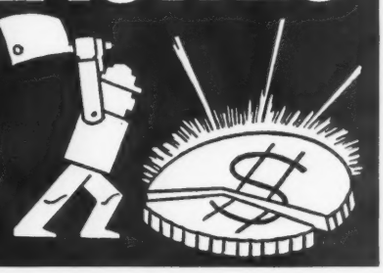
Heat Transfer

APPLIED HEAT TRANSMISSION (1941). *By H J Stoever, Associate Professor of Mechanical Engineering, Iowa State College. Published by McGraw-Hill Book Co, 330 W 42nd St, New York, N. Y. 226 pages, 6x9 in. illustrations and tables. Price $2.50.*

This book on the how and why of

(*Continued on page* 146)

IRON FIREMAN SLASHES FUEL COSTS 67%



Lynchburg Foundries Operate Twenty Iron Fireman Stokers

Here's the way fuel costs dropped when 20 Iron Fireman stokers replaced hand-firing of coke in the core-ovens in the two plants of the Lynchburg Foundry Company, of Lynchburg and Radford, Va.

Fuel cost for curing cores, per ton of metal cast

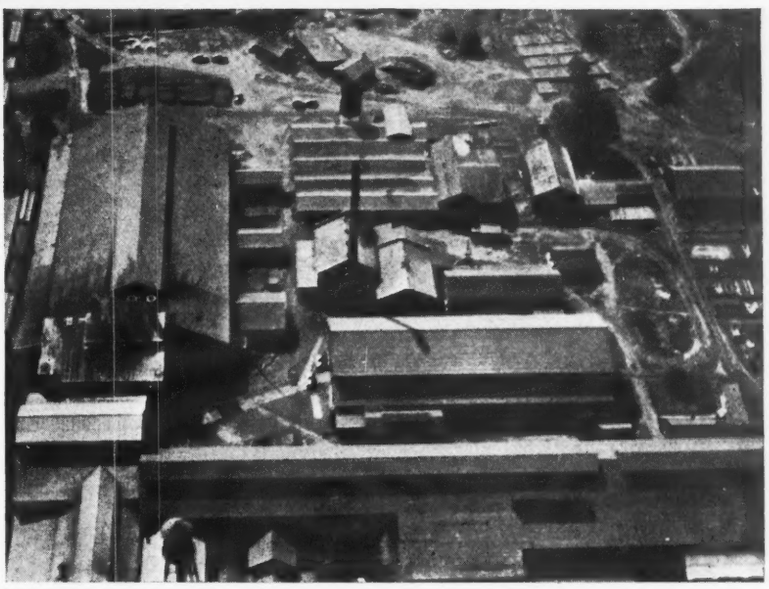
***Before* Iron Fireman firing...$3.25**
***After* Iron Fireman installed.. 1.08**
***Iron Fireman Savings*.....$2.17, or 67%**

Maintenance Cost Practically Nil

Four years ago Lynchburg bought a complete set of spare dead-plates and tuyeres. But not a single dead-plate or tuyere has been replaced. Maintenance record cards show that the mechanical maintenance has been practically nil and only normal expected electrical maintenance for equipment located in a foundry has been experienced.

Helps Produce Better Product

With hand-firing, Lynchburg suffered losses from burning of cores. Iron Fireman's accurately controlled firing has completely ended this loss. Iron Fireman has also cut labor costs, by reducing the number of men needed to watch the ovens.

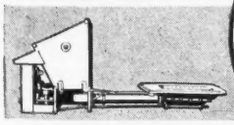


Learn what YOU can Save

POWER ENGINEERS: Our technical staff will gladly collaborate with you in making an Iron Fireman Engineering Survey that will determine, with engineering accuracy, the results that Iron Fireman firing can produce in your own plant. We cover more than 100 items in our standard survey; you can check the data every step of the way. No obligation. Just mail coupon.

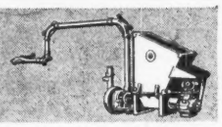
Top: Air view of the 25-acre Radford Pipe Works, Radford, Va., division of the Lynchburg Foundry Co. *Below:* Arthur Roberts, Jr., Chief Engineer.

IRON FIREMAN Automatic Coal Stokers



Iron Fireman Poweram stoker combines worm feed and ram distribution of coal in retort.

THE IRON FIREMAN
TRADE MARK REG. U. S. PAT. OFF.



Iron Fireman Pneumatic Spreader fires coal on a stream of air or hot furnace gases.

IRON FIREMAN MANUFACTURING CO., (Portland, Ore.; Cleveland; Toronto.)
Mail to 3011 West 106th Street, Cleveland, Ohio.
☐ See us about making an Iron Fireman Engineering Survey of our steam costs.
Send: ☐ Poweram Catalog. ☐ Pneumatic Spreader Catalog.

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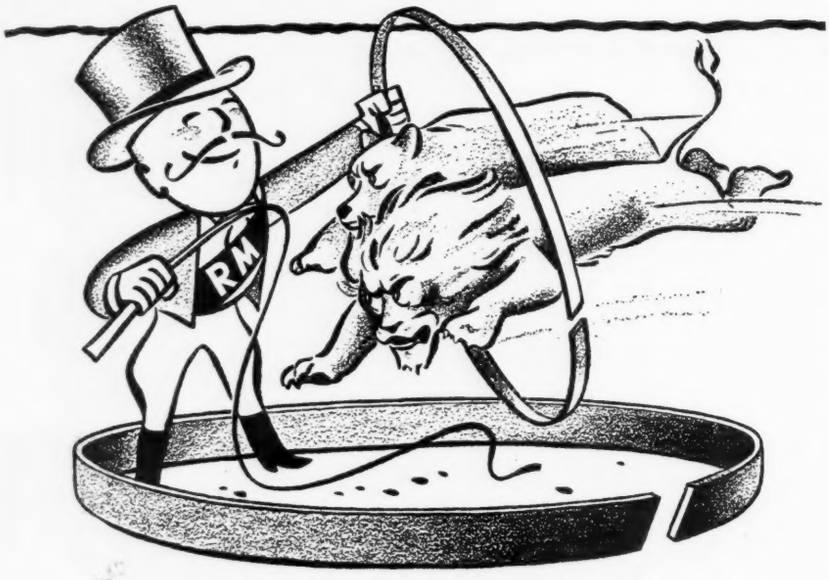

When super-heated steam starts bubbling, when corrosive gases leak or oil drips, remember that R/M packings have earned the nickname, Ringmaster, because of their control of any situation. Just specify Raybestos-Manhattan, and you'll find fluids whipped back into line smoothly and for a long time.

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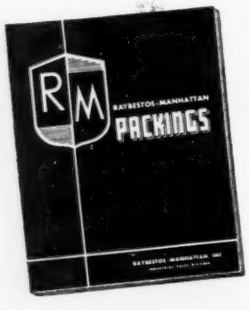

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heat transfer can be used by either the practising engineer or student to make simple calculations as well as more complex academic exercises. Numerical problems worked out in detail cover such everyday applications as double-pipe heat exchangers, steam pipe coils and evaporators. The theory is worked for those who want understanding; simplified calculations aid in getting quick, reasonable answers.

Chapter headings include conduction, radiation, convection, calculation of pressure drop (where fluid flow affects design), insulation and a well-illustrated section on types of industrial heat-transfer equipment showing the construction details of feedwater heaters, condensers, evaporators and hot-water-supply heaters. Data on convection coefficients are presented as charts and tables, making for quick selection of the proper figure for practical work.

Power Factor

POWER-FACTOR PROBLEMS IN ELECTRICITY SUPPLY (1941). *By G W Stubbings. Published by the Chemical Publishing Co, 148 Lafayette St, New York, N. Y. 174 pages, 5x7 in., 35 illustrations, cloth binding. Price $3.50.*

Power factor of alternating-current circuits is something that many authors have tried to make understandable to non-technical minds. Here is another attempt which presents a simple and comprehensive explanation of the problems arising from low power factor of alternating-current systems for plant engineers, electricians and students.

The principal sections of this book explain the meaning of power factor, tell what causes low power factor and its effects on cost of power, how to correct low power factor and the economies to be realized by doing so. One chapter is devoted to power-factor calculations. Many examples are worked out in other chapters to show how to solve problems associated with alternating-current power. Another chapter covers methods of measuring power factor. The problems are handled in a practical way with the use of nothing more than simple algebra.

Brief Reviews

TURBULENT FLOW OF SLUDGES IN PIPES. *By Harold E Babbitt and David H Caldwell, professor of sanitary engineering and research assistant in Civil Engineering, respectively. Published by Engineering Experiment Station, University of Illinois, Urbana,*

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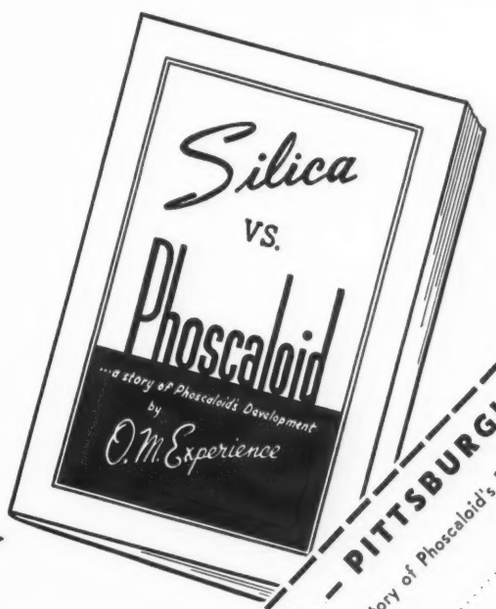

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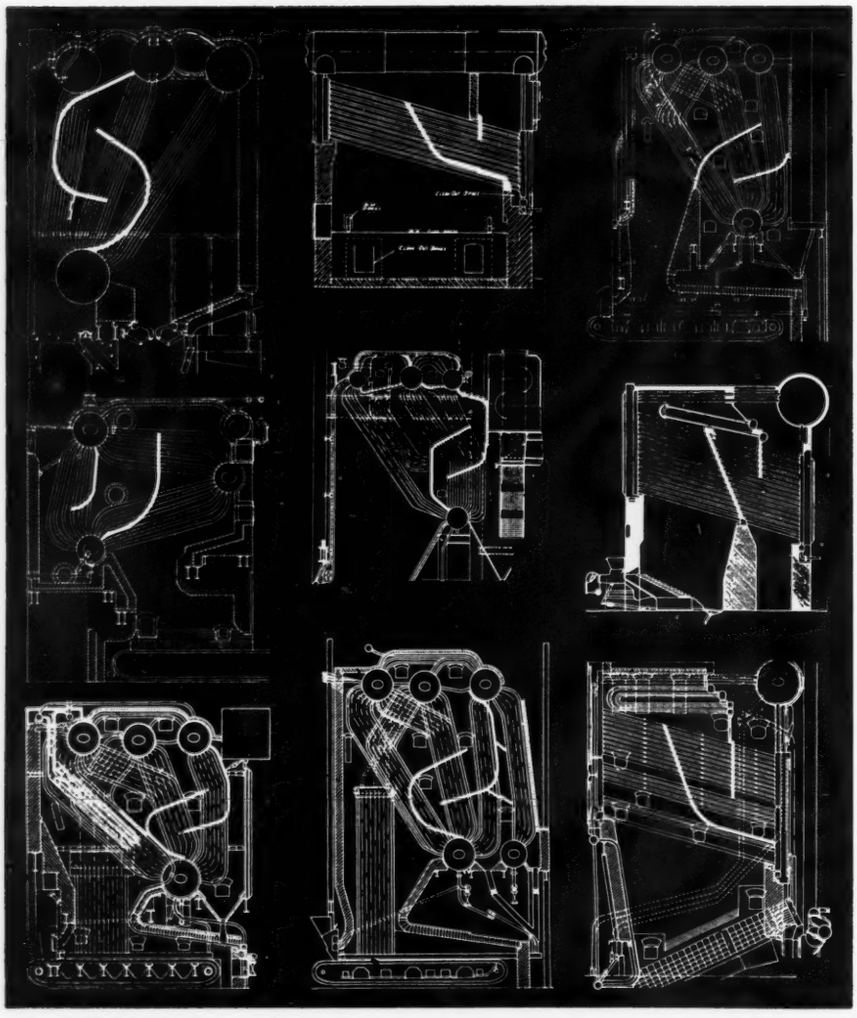

Installation of ENCO Baffle Walls in all types of water tube boilers has resulted in immediate improvement in performance, operation and maintenance.

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Ill. Price $.45.—Object of this investigation was to formulate factors affecting the turbulent flow of sludge. The bulletin presents, for various types of sludge, data to be used in design of pipelines and pumping machinery for conveying various types of sludge.

REPORT OF THE RESEARCH AND EXTENSION ACTIVITIES. *Published by Engineering Experiment Station, Purdue University, Lafayette, Ind. Free.*—Report is divided into two parts. First has record of researches carried on the Engineering Experiment Station and in the several engineering schools and departments. List of graduate and undergraduate theses is included. Second part is a record of activities of Engineering Extension Department carried on in cooperation with the several schools and engineering departments of the university.

ELECTRICAL YEAR BOOK. *Published by Emmott & Co, Ltd, 31 King St, West, Manchester 3, England. Tables, charts, drawings. Price 2 shillings, or about 50 cents.*—Among new matter in 1941 edition is explanation of superimposed "ripple" successfully developed for use with alternating currents for exercising control at a distance. Regular engineering tables, etc, also included.

CURRENT HYDRAULIC LABORATORY RESEARCH IN THE UNITED STATES. *Compiled by National Bureau of Standards, U. S. Department of Commerce, Washington, D. C. Available to interested persons or organizations without charge. Refer to index number: VI-6LINHU.*—Presents all information, such as purpose, method and scope, progress, etc, of current projects in hydraulic laboratories in the United States.

CABLE OPERATION—1939. *Published by Edison Electric Institute, 420 Lexington Ave, New York, N. Y. Price $.60 to members, $1.50 to non-members in U. S., and $1.60 to foreign countries.*—This booklet is a report of the Transmission and Distribution Committee, Edison Electric Institute, covering trouble rates, and the operation of 16,400 miles of cable, 336,000 joints, and 47,900 potheads.

LEFAX DATA. *Published by Lefax, Inc, Philadelphia, Pa.*—Recent Lefax bulletins of interest to POWER readers are the following: No. 13-145, "Roller Chains and Sprockets for Power Transmission"; No. 41-4, "The Dynamic Symmetry Curve".

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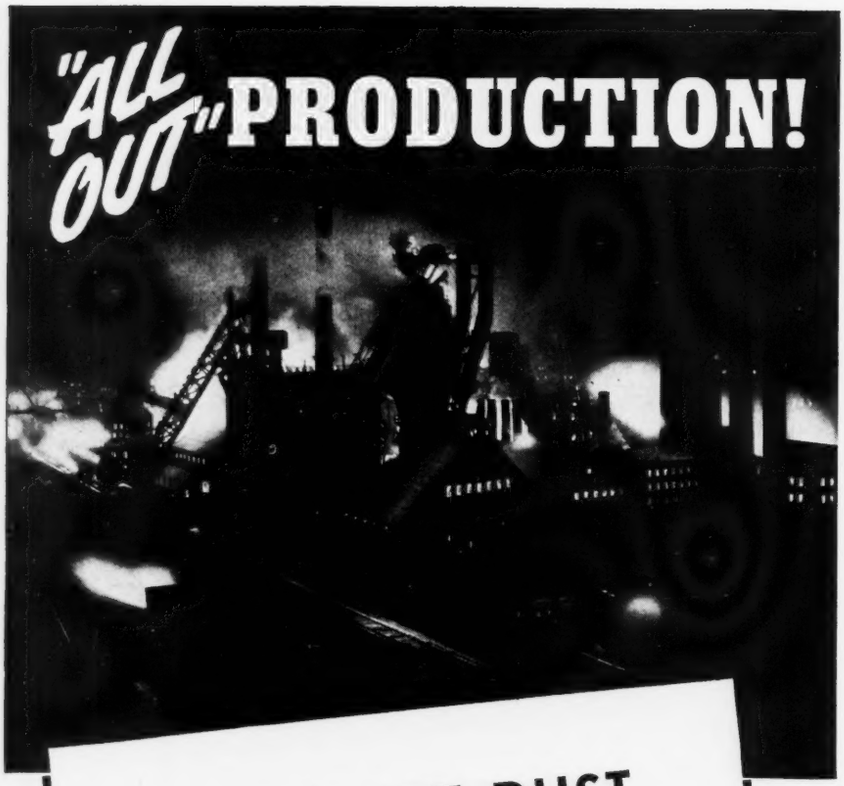

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Nights are bright with the fires of industry, as men and machines swing into "all out" production for defense. Dust, the inevitable by-product of industry, can, if uncontrolled, sabotage production by reducing efficiency, increasing rejects, running up costs.

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DUST COLLECTORS

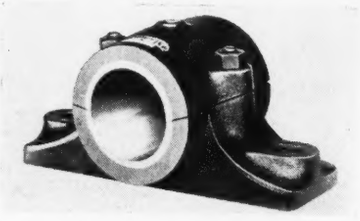
New Plant Equipment

(*Continued from page* 128)

are a single-unit motor-generator set, consisting of squirrel-cage induction motor driving a series dc generator which supplies operating voltage for a dc series motor coupled to the driven load. In parallel with generator field is a rheostat which controls driving motor speed. Control apparatus consists of an across-the-line starter for squirrel-cage motor and pushbutton station. Optional features include dynamic braking and inching. Dynamic breaking requires no external braking register, but employs a braking field wound right into motor. Horsepower ratings are based on top speed of 1750 rpm at 40 deg C, continuous operation. *Westinghouse Electric & Mfg Co, East Pittsburgh, Pa.*

Bearing

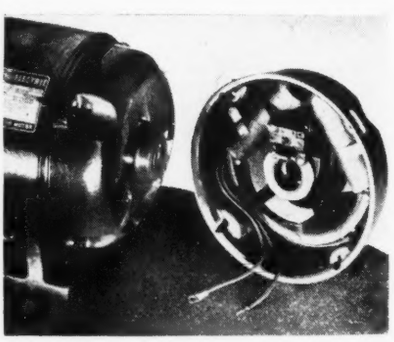
BABBITTED-BEARING common flat box has maroon-colored crackle-finish housing, and is available from stock in 24 sizes, for shafts of ½ to 3 in. diameter. Sloping surfaces between cap and base maintain concen-



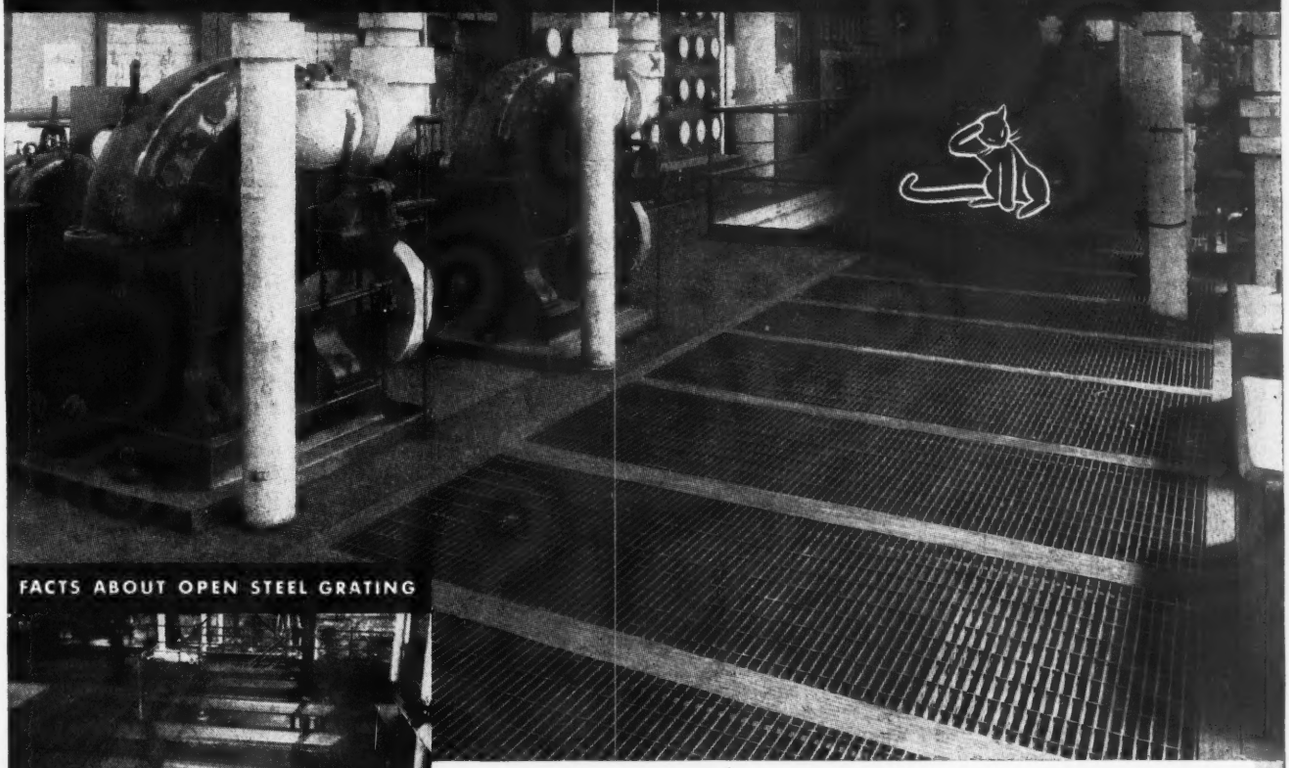
tricity and relieve cap bolts of direct strain from side thrust. Cap is tapped for grease cup or hydraulic fitting, groove in bore assuring proper distribution of lubricant. *Link-Belt Co, 307 N Michigan Ave, Chicago, Ill.*

Capacitor Motor

TRI-CLAD CAPACITOR MOTOR offered in addition to line of tri-clad motors recently announced. Like polyphase tri-clad, capacitor motor features modern appearance, better mechanical and electrical protection, as well as protection against operating wear and tear. New motor may be obtained with either ball- or sleeve-bearing construction, and is avaliable in two types. Type KC is designed particularly for applications re-



THIS FLOOR CLEANS ITS OWN FACE



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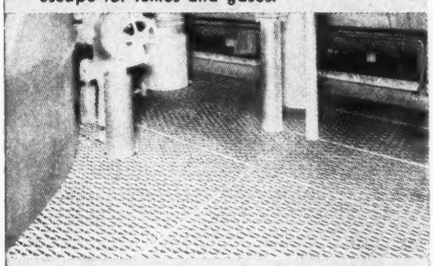

ECONOMICALLY INSTALLED. Every section of Open Steel Grating is built to the requirements of the individual job. This factory layout insures speedy installation and perfect fit.

FLOORS of Open Steel Grating differ radically from ordinary, old-fashioned floors. They are factory fabricated from a combination of structural members rigidly connected by riveting, welding or interlocking. Though strong and rigid, their weight is the minimum necessary to carry and distribute a given load with an ample factor of safety.

Being open in construction, Open Steel Grating floors and steps do not accumulate dust, dirt, grease, oil or moisture on their bar edges. Used for outside walks, they do not collect snow, ice or water. *They are virtually self-cleaning—clean their own face.*

This self-cleaning feature is but one of the many you'll find in Open Steel Grating floors and steps. If you are confronted with a problem of securing rigid, durable, non-slip, firesafe floors that can be installed quickly—that will provide maximum air circulation, you'll find the answer, together with detailed specifications, in this new free booklet. Write today for your copy.

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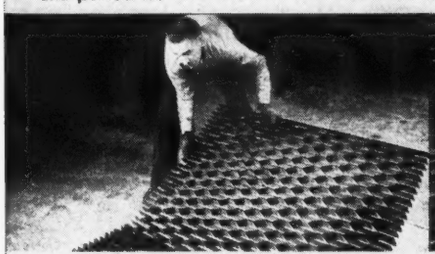

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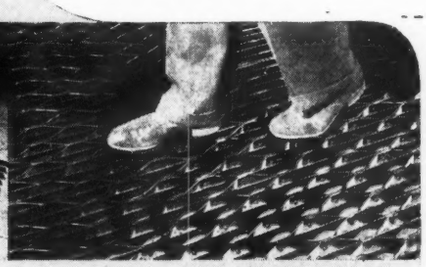

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quiring moderate starting torques, such as fans, blowers and centrifugal pumps, while Type KCJ is made especially for compressors, loaded conveyors, reciprocating pumps, and other applications requiring high starting torques. Capacitors are mounted inside end shield on normal-torque motor, as in illustration, while on high-starting-torque motors, 1½ hp and larger, capacitors are mounted in compact case on top of motor frame. *General Electric Co, Schenectady, N. Y.*

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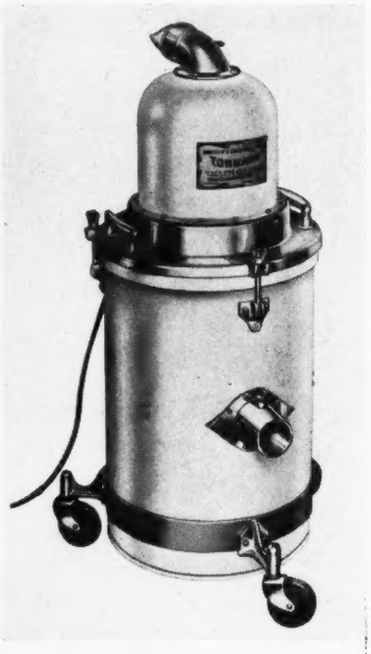

and filter give plenty of space for dirt accumulation. Attachments and cleaning tools available for removing dust, litter, chips, etc, from units in course of assembly, and for cleaning boiler tubes and boiler tops. *Breuer Electric Mfg Co, 5100 N Ravenswood Ave, Chicago, Ill.*

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"FREE FLOW" VIBRATING CONVEYOR and feeder operate on lift-throw principle with trough motion becoming increasingly horizontal with progress of each cycle, thus imparting gentle forward motion to conveyed material. Oscillating arms which actuate trough are mounted in rubber bushings, which store forward and return forces, reducing power consumption to minimum. By variable-speed control of trough-oscillation rate, volume can be controlled as desired, and material can be conveyed up inclines to 15 degrees. *Standard Transmission Equipment Co, 416 West 8th St, Los Angeles, Calif.*

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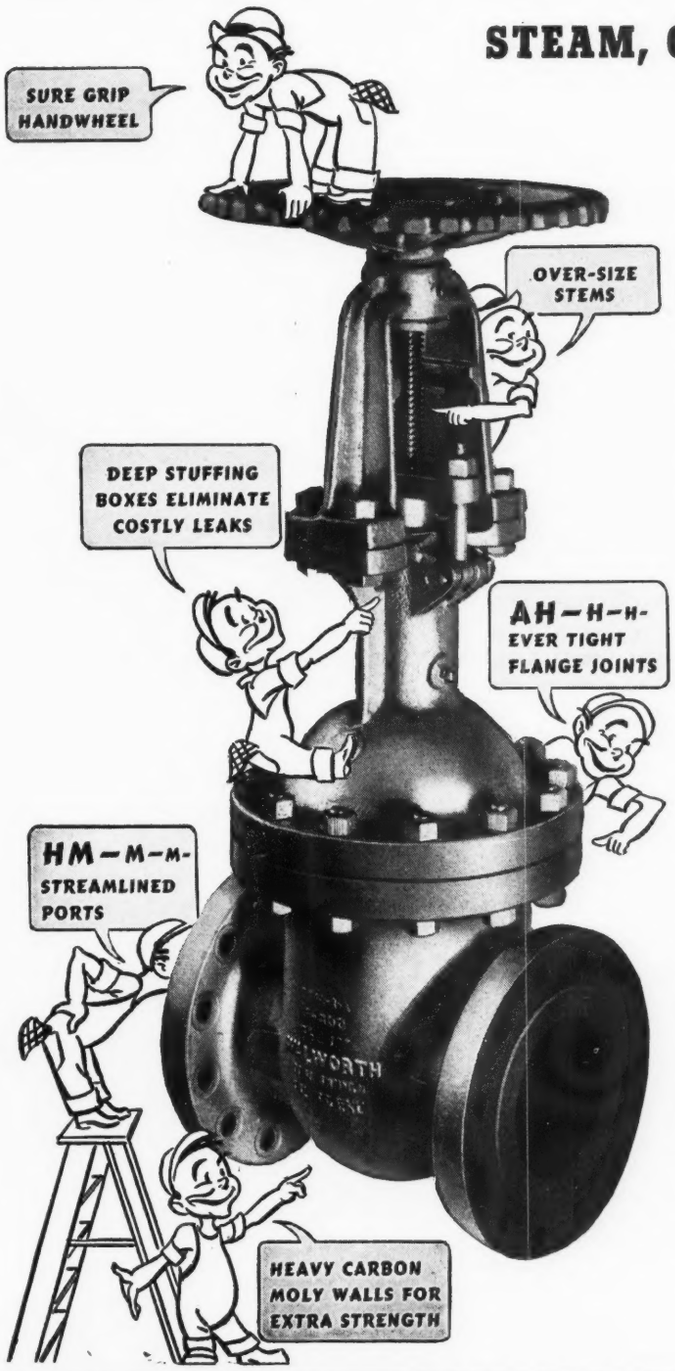
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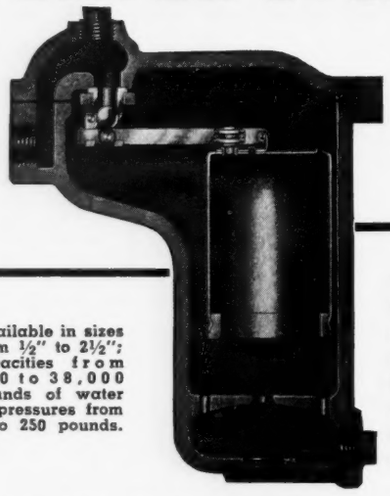
CRYER STEAM TRAPS

are Guaranteed to Solve Your Problem



Available in sizes from ½" to 2½"; capacities from 500 to 38,000 pounds of water at pressures from 0 to 250 pounds.

You can safely put your trap troubles in the hands of CRYER, because you are assured by our guarantee that these accessible, positive acting, quick venting INVERTED BUCKET STEAM TRAPS will discharge condensate at rated capacities—that they will perform satisfactorily within their limits of pressure and capacity.

Put a Cryer to work. Installation is simple and easy. Give it a chance to show you how it saves steam and increases steam distribution efficiency. You'll find it quickly pays for itself and definitely stops dribbling, slow venting, air binding and unreliable drainage. You'll find too that it will give long service with minimum maintenance because all parts are sturdily made of corrosion-resisting materials.

INVESTIGATE NOW

It will pay you to investigate *now* by getting complete details.

CRYER
TRAP & VALVE CO., INC.
366 Madison Ave.
New York, N. Y.

We carry all sizes of traps, and repair parts of the line formerly known as the J-M Ball Steam Trap.

MANUFACTURERS OF STEAM SPECIALTIES FOR MORE THAN 40 YEARS

ONLY AS GOOD as the JOB it Does!

That's Lubrication—

and you'll never know its real *value* 'till your machinery *proves* it! ★ Made-for-the-Purpose LUBRICANTS keynote a *sixty-six* year Quality demonstration of our Brands of . . .

LUBRICATION

TURBINE OILS **COMPRESSOR OILS**
CYLINDER OILS **DYNAMO OILS**
DIESEL ENGINE OILS **MOTOR OILS**
GREASES . . . *for every requirement.*

BORNE SCRYMSER COMPANY
ESTABLISHED 1874
17 BATTERY PLACE • NEW YORK

Metallizing Gun

TYPE 2E GUN has two features. These are the "controlled power unit", which gives uniform and steady wire feed for production service and eliminates need for gear changes; and "Universal Gas Head", which allows use of acetylene, propane, hydrogen, natural or manufactured gas with balanced pressures and without changing heads. Metal wire is automatically fed into gun at

adjustable speed, where it is melted by concentrated flame, atomized by compressed air and sprayed on any base material. Equipment can be used in hydro plants to repair cavitated water-turbine runners, and for coating overflow gates, while in steam plants gun can be used to restore eroded sections between turbine blade rows, building up turbine shafts, etc. *Metallizing Engineering Co, Inc, Long Island City, N. Y.*

Boiler-Water Comparator

OUTFIT FOR DETERMINING PHOSPHATES and pH in boiler water is molded from plastic and works on slide principle. Phosphate comparator covers range 5 to 100 and low phosphate comparator 0 to 25 ppm of phosphate as PO_4. Boiler-water set consists of either phosphate set and three pH color standard slides covering pH range 7.2 to 11.6. Phosphate and pH slides work on same base, and all equipment is contained in portable wooden case. Maker says presence of silica, ferrous, ferric iron or sulphites causes no error in phosphate determination. *W A Taylor & Co, Inc, 7300 York Rd, Baltimore, Md.*

Plastic Compound

"INSULMAT" has been designed to eliminate condensate drip from air ducts, etc. It is spray-on plastic compound, containing specially treated cork particles. Compound is self-bonding, requires no priming coat, adhesive or supports, and can be applied to any metal surface. *J W Mortell Co, Kankakee, Ill.*

Circuit Breaker

MAGNE-BLAST CIRCUIT BREAKER announced in higher rating, to meet demand for breaker for severe industrial service. New

THEY GAVE ME 2 WEEKS TO MAKE NEW DRAWINGS...I HAD THEM READY IN 4 DAYS

"I SMILED when the Chief Engineer handed me his notes at the end of the conference with the Production Chiefs. When he said, 'Bill, have your draftsmen make these changes . . . corrected drawings must be ready in two weeks,' I knew I would give him and the rest of the boys a big surprise.

"For years we've had the same problem of rushing out drawings on new models. Last minute changes demanded by the production department always proved a Jonah . . . disrupted the whole drafting department for weeks.

"But I knew it was going to be different this time. Now, with an Ozalid machine installed right in the drafting room, we were all set to make changes in a hurry.

"What a time-saver for a drafting department, I thought, as I realized we were going to cut our drafting time from weeks to days. Here's how we did it.

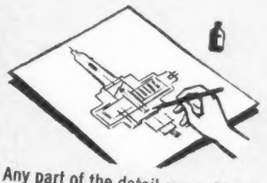
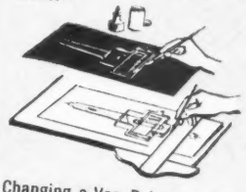
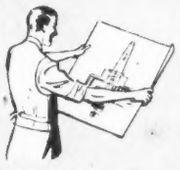
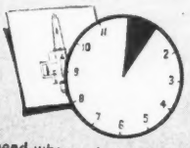
"We made Ozalid transparent duplicates of all drawings to be revised . . . deleted that part of the design to be changed with Ozalid Corrector Fluid . . . drew in corrected details and specifications in pencil. ***Result*** . . . altered transparent prints which actually are new originals . . . prepared in a fraction of the time required to make the same changes by the Van Dyke Process or by retracing.

"But how do you like this—when I handed the complete job to the Chief Engineer 10 days ahead of schedule, he never batted an eye. I couldn't understand it, and it wasn't until later that I found out he knew about the Ozalid Process all along and had told one of the boys to put me wise to the savings possible with an Ozalid installation. Was my face red!

"Let me give you Chief Draftsmen some sound advice: Don't make the same mistake I did. Don't wait until the Boss gives you a hint before you investigate the short cuts in drafting possible with Ozalid transparent duplicates. Don't delay. Get the facts today."

SPECIFY Ozalid WHITEPRINTS

Advantages of OZALID TRANSPARENT DUPLICATES OVER VAN DYKE NEGATIVES

OZALID	VAN DYKE
Ozalid transparent duplicates save retracing and are made in 2 easy steps with standard equipment in the same simple manner as Ozalid whiteprints.	Van Dyke negatives are made in 5 steps by a method that requires much space and is complicated by the use of running water, special trays, printing frames and drying areas.
 Any part of the detail on an Ozalid transparent duplicate can be deleted with Ozalid Corrector Fluid. Changes or additions can be made on the same print with either pencil or ink taking only one-quarter to one-third the time required to make similar changes by the Van Dyke method.	 Changing a Van Dyke negative is a complicated process requiring opaque, paint brush and a corrector fluid which is often unsatisfactory. Practical results are usually secured only when the changes are "blocked out" on the Van Dyke negative and another positive Van Dyke or photo cloth copy is made and reworked.
 Ozalid transparent duplicates are true-to-scale and are permanent. They do not deteriorate with age.	Van Dyke negatives are subject to distortion and unless properly dried often become brittle.
	

The speed when printing from an Ozalid transparent duplicate is 3 to 5 times faster than the printing speed possible with a Van Dyke negative.

OZALID PRODUCTS DIVISION

GENERAL ANILINE & FILM CORPORATION

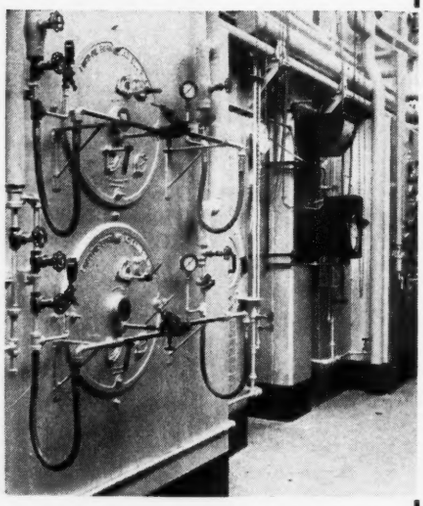
JOHNSON CITY, N. Y.

Ozalid in Canada • HUGHES OWENS CO. LTD., Montreal

Enco Burners

. . . . . *for the efficient combustion of all grades of*

OIL, TAR or GAS



Burner Units of Steam or Mechanical Atomizing Types in various sizes with capacity ranges of from 1 to 1000 gals. per hour.

Designed for operation either with or without air register for natural or forced draft.

The ENCO Interchangeable Oil Burner is designed for instant change of atomizer gun for operation by either steam or mechanical (pressure) system or to cover a wide range of capacity. ENCO Oil Atomizers are being applied to various types of standard pulverized coal and gas burner units to provide a dual fuel unit for cold starting or for full load operation when coal or gas is not available or when oil is the more economical fuel.

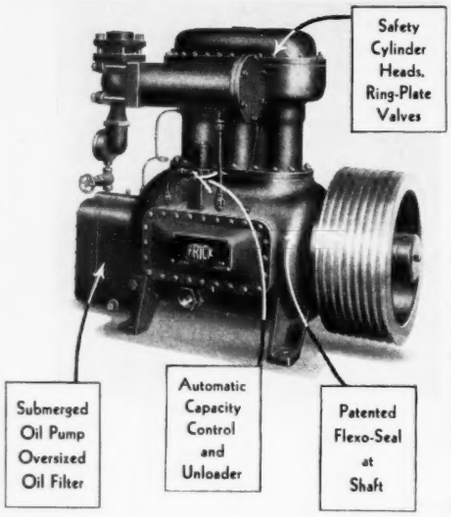
We have made many installations and would be glad to cooperate with those looking for better operation and assurance against loss of steam output.

Write for Bulletin OB-40 and 37 describing ENCO Oil Burning, Pumping and Heating Equipment.

THE ENGINEER COMPANY

75 West St., New York, N. Y.

Distinctive Advantages Announced for the New


Safety Cylinder Heads, Ring-Plate Valves
Submerged Oil Pump Oversized Oil Filter
Automatic Capacity Control and Unloader
Patented Flexo-Seal at Shaft

Eclipse Refrigerating Machines

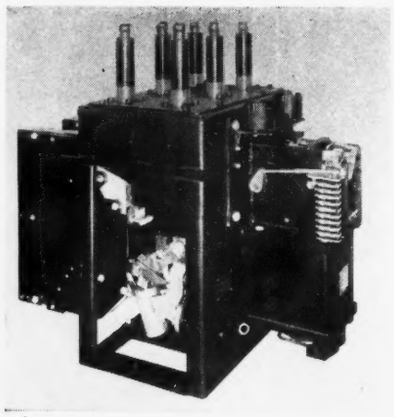
Don't buy ANY Freon-12 compressor until you've seen the new Frick Eclipse line! Built in three sizes, these phenomenal machines give capacities up to 60 tons refrigeration . . . in units so compact, light, efficient, and quiet they can be installed almost anywhere . . . and at a material saving over older types!

Only in the Eclipse line can you get all the exclusive advantages shown, plus such features as higher operating speeds (up to 900 r.p.m.), force-feed lubrication throughout, direct-connected motor drive when desired, pistons with 5 rings, etc., etc. Nearly 60 years' refrigerating experience built into them.

Write, wire or phone your Frick Branch or Distributor for full details today. Or, get in touch with

Frick Co., Waynesboro, Penna.

1. **Patented Flexo-Seal at Shaft.**
2. **Safety Cylinder Heads with Ring Plate Valves.**
3. **Automatic Capacity Controls and Unloaders.**
4. **Submerged Oil Pump and Over Sized Screen.**
5. **"Parallel" Operation, using Frick Oil Equalizing System.**



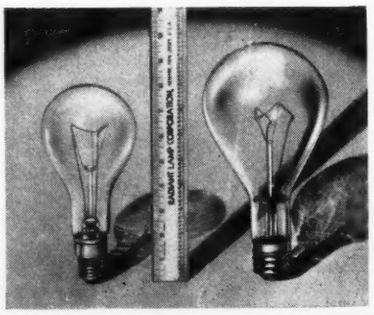
breaker is rated 250,000 kva for services from 4200 to 7500 volts, and has all fundamental advantages of smaller magne-blast breakers. Solenoid mechanism is mounted on front of breaker and isolated from it by heavy steel panel. Maker says higher insulation and service voltage ratings have been obtained by careful coordination of insulation in arc chute, increased phase spacing, and a separate box-carrier for each phase. Principle of driving arc into an interleaving chute by means of magnetic blowout coils has been retained in newer models, together with contact-design principle of other breakers. Breaker framework provides rigid support for arc chutes, contacts and mechanism. Besides support given by bushings, contact structure is given additional rigidity by heavy-duty porcelain insulator from contacts to frame. *General Electric Co, Schenectady, N. Y.*

Pushbutton Station

No. 202 COLT PUSHBUTTON STATION styled for use with streamlined machines, designed for surface mounting. Cover is heavy molded phenolic, with guard ring raised to full height of start button to prevent accidental operation. Usual mounting is vertical, but if horizontal mounting is desired, buttons can be turned to read correctly in that position. Internal mechanism is self-contained on rugged molded block, which is mounted directly on metal base by two screws. *Electrical Div, Colt's Patent Fire Arms Mfg Co, Hartford, Conn.*

Industrial Lamps

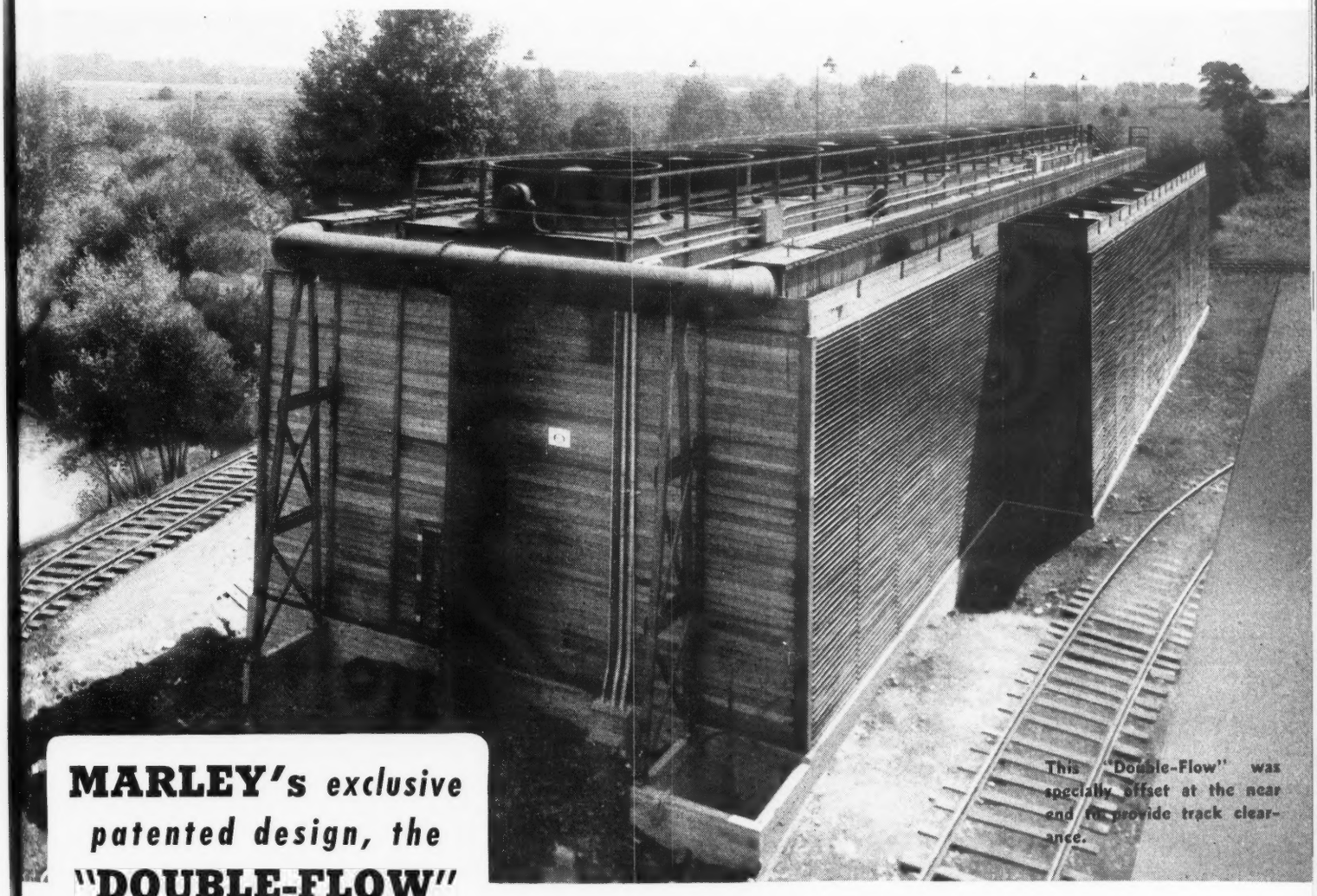
HIGH-WATTAGE INDUSTRIAL LAMPS have been reduced in size and made with weatherproof glass to withstand thermal shocks. Use of hard glass bulb has made it possible to re-



GREATER SAVINGS

than any other type of large-capacity COOLING TOWER

See actual operating comparative records for yourself!



This "Double-Flow" was specially offset at the near end to provide track clearance.

MARLEY's *exclusive patented design, the* **"DOUBLE-FLOW" INDUCED DRAFT COOLING TOWER,** *has established unparalleled efficiency and economy records in a great variety of heavy-duty services.*

The hard, clear facts and figures are available from your near-by Marley representative or WRITE TODAY for BULLETIN 602.

1. A New Low in Pumping Head

accomplished by a new design that lowers tower height drastically, minimizes pipe friction loss and provides an unusually efficient water distribution system. (This saving alone reaches important proportions on most installations.)

2. A New High in Efficiency

by eliminating "recirculation" of hot, saturated discharge air. This evil robs large forced-draft towers of 8% to 20% efficiency and the loss is most exaggerated in forced draft units of broad, low design. Also "Double-Flow" efficiency is heightened by the best mixing of moving air with finely-broken water yet devised by water cooling engineering and by unusual provision for operating flexibility.

3. A New Minimum of Maintenance

by using the ONLY completely external water distribution system with all parts in easy sight and reach—by superstrength construction and rugged mechanical dependability—and by positive elimination of many former operating problems.

1-41-B

The MARLEY Company

Fairfax and Marley Roads
Kansas City, Kansas

MARLEY WATER COOLING EQUIPMENT is saving money and promoting efficiency in all kinds and sizes of plants throughout industry

YARWAY INVOLUTE SPRAY NOZZLES

Unique Yarway Involute design.

No internal parts or vanes to clog or erode.

Unobstructed flow gives minimum loss of head.

Finely divided spray cone provides rapid cooling.

Renewable orifices adapt nozzles for any service.

Installations total more than 5 million gallons per minute in water cooling and air conditioning service.

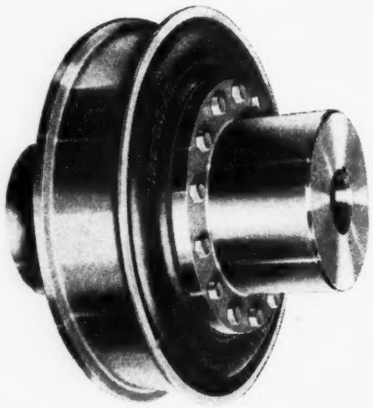
Made in both cast and bar-stock types. All sizes from ¼ in. to 2½ in. Write for Catalog N-615.

YARNALL-WARING COMPANY
100 Mermaid Ave. Philadelphia

duce size of 500-watt lamp to that of ordinary 200-watt lamp, using conventional medium socket instead of mogul base. Photo shows both lamps, newer one on left, showing size comparisons. *Radiant Lamp Corp, 333 Sherman Ave, Newark, N. J.*

Flexible Coupling

AIRFLEX FLEXIBLE COUPLING is designed for connecting diesel, oil, gasoline or gas engines to any type of driven machinery. Decreases peak torque values when prime mover or driven equipment has high fluctuating torque characteristic. Unit consists of special resilient rubber gland lined with pre-moulded, pre-vulcanized cylindrical section specially treated to prevent air loss.



This cylindrical lining is covered with multiple alternating layers of tough durable fabric and live rubber, and entire gland is permanently bonded to rugged steel inner and outer rims. Gland is inflated to proper pressure through specially designed standard thread Schrader valve which will take any hand-pump fitting or air nozzle. Six types of couplings available, for various drives and connections. *The Falk Corp, Milwaukee, Wis.*

Explosion-Proof Pump

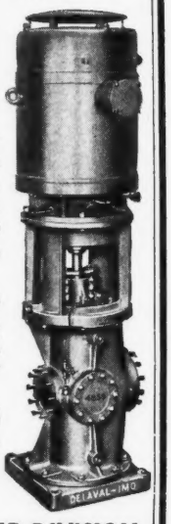
EXPLOSION-PROOF PUMP is newest addition to line of miniature pumps, and bears Underwriters Class 1, Group D label of approval. Maximum capacity is 5.7 gpm, with a maximum pressure of 16 lb psi. Nozzles threaded for ¼-in. standard pipe fittings. Pumps are manufactured in stainless steel, Monel metal, chromium-plated bronze, brass, cast iron, Hastelloy and other alloys. *Eastern Engineering Co, 45 Fox St, New Haven, Conn.*

Spiral Packing

PALMETTO HIGH-PRESSURE SPIRAL PACKING is made of closely woven asbestos cloth with center block laid up against flat strip of heat-resisting, resilient red rubber. Cover or wear face is firmly bonded to center to make strong square-cornered packing. Packing is spiraled on a mandrel and vulcanized, then exclusive lubricating process is applied. *Greene, Tweed & Co, 101 Park Ave, New York, N. Y.*

IMO Rotary OIL PUMPS

("IMO" means "I Move Oil")



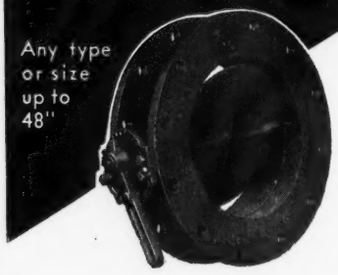
THE unit illustrated, although occupying only a 20 in. square of deck space, delivers 500 g. p. m. of turbine lubricating oil.

IMO Oil Pumps are available in all capacities, for all pressures, and for all kinds of oil.

Catalog I-64 describes them in detail.

IMO PUMP DIVISION
of the
De Laval Steam Turbine Co.
Trenton, N. J.

The last word in Blast Gates...

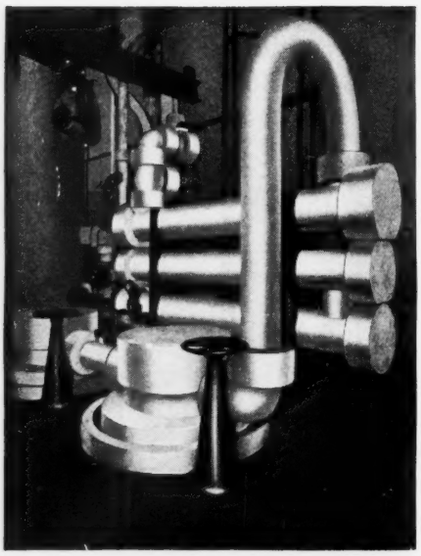


ROCKWELL'S complete line of Blast Gates meets every possible requirement. Strong, light, and air-tight, they assure perfect control of air. Superiority has been demonstrated by thousands used throughout Industry.

Ask for Catalog No. 4020

W. S. ROCKWELL COMPANY
Blast Gate Division
50 CHURCH STREET NEW YORK, N. Y.

SAFE · DEPENDABLE · ACCURATE
IN step with America's national defense program—working for the preservation of America's institutions and the protection of America's future through the fast production of precision piping for power and industrial plants. That's our definite schedule.
BENJAMIN F. SHAW COMPANY
Since 1893 Wilmington, Delaware
SHAW PIPING
PREFABRICATION and INSTALLATION



When ALL LOADS are PEAK LOADS

Boilers must be kept at peak efficiency

ALL THE TIME!

HENSZEY

CONTINUOUS BLOWDOWN

insures steady uninterrupted, full-capacity boiler service! Scale deposits, foaming, priming, and carry over can be prevented so that even through long periods of heavy loads you may have CLEAN BOILERS, CLEAN WATER, and CLEAN STEAM.

The Henszey Continuous Blowdown System continuously and automatically draws off trouble-making boiler water impurities at a rate that keeps the boiler water concentrations at a predetermined proper degree. And this is accomplished *without heat loss!*

- Saves up to 96% of the heat ordinarily lost with intermittent blowdown.
- Produces clean steam—no carry over.
- Prevents Priming and Foaming.
- Prevents scale—with simple chemical treatment.
- Automatically controls Boiler Water Concentration.
- Indicates and Meters Blowdown.
- Practical for any size plant—large or small.

We will gladly make an analysis of the boiler water problems of your plant to show you what savings can be made by proper boiler water concentration control. Remember Henszey can furnish you with *any* type of system.

Do it now—Send for latest bulletin

HENSZEY COMPANY

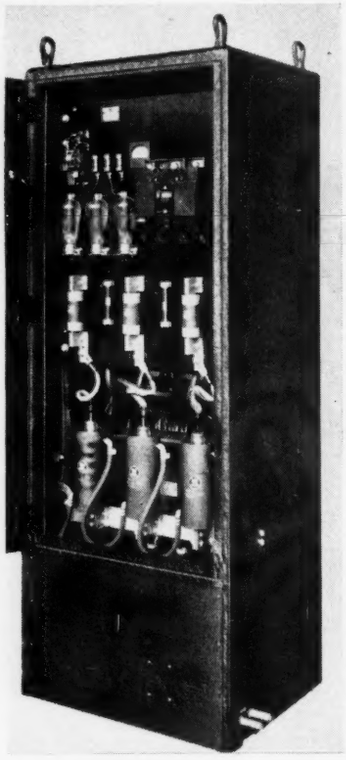
Dept. D-5 Watertown, Wis.

HENSZEY

BOILER WATER CONCENTRATION CONTROL SYSTEM

Spot Welding Rectifier

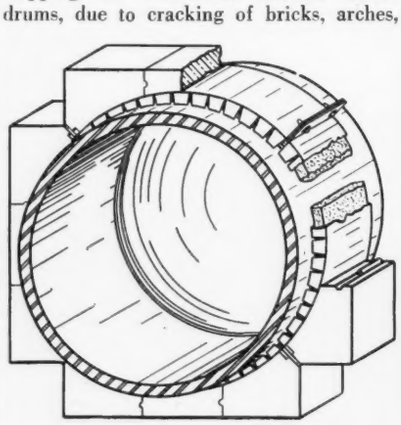
RECTIFIERS AVAILABLE in two capacities, one for use with 40-kw and other for 120-kw-spot welder. Each rectifier will operate two welders if they are sequenced so that only one can be loaded onto rectifier at same time. Unit consists of a control and protective panel, power transformer and ignitron tubes, all contained in a forced-ventilated, floor-mounted, sheet-metal cabinet, with heavy welded-base frame. Tubes are



arranged for water cooling, and cooling is controlled by thermostatic water-flow switch. Control and protective panel is in top of cabinet and ignitron assembly in bottom. Hinged doors provide access to cabinet front; back is removable for maintenance. A 14-in. fan, driven by ⅛-hp motor, cools transformer, exhausting through a grill at rear of cabinet. *Westinghouse Electric & Mfg Co, East Pittsburgh, Pa.*

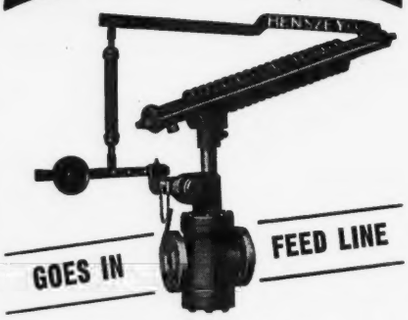
Drum-Sealing Rings

REINTJES DRUM-SEALING RINGS used for stopping air infiltration around boiler drums, due to cracking of bricks, arches,



HENSZEY

BOILER FEED REGULATORS



The Henszey Boiler Feed Regulator controls boiler water levels continuously and accurately under *all* load conditions!

These simple, compact, self-contained units go right in the feed line and require no additional structural support. They are as easy to install as a simple gate or globe valve. Once installed and set for operation no further attention is necessary — nothing to get out of order — nothing to reset.

Send for latest Bulletin containing full details.

HENSZEY COMPANY

Dept D5—Watertown, Wis.

WATER REFINING EQUIPMENT HEADQUARTERS

INDUSTRIAL—PROCESS
RAILROAD—MUNICIPAL—HOUSEHOLD

Mobile Units for softening boiler feed water are available.

Whatever your water refining requirements . . . mobile . . . or stationary . . . The American Water Softener Company has equipment to give the answer desired . . . this Company has pioneered . . . has practiced this art more than 40 years . . . and now is indisputably "Water Refining Equipment Headquarters" . . . the oldest Engineering and Manufacturing Concern concentrating exclusively on Water Refinement.

Tell us of your Water Problems . . . we can help you.

The AMERICAN WATER SOFTENER COMPANY

WATER REFINING EQUIPMENT HEADQUARTERS
INDUSTRIAL • PROCESS • RAILROAD • MUNICIPAL
HOUSEHOLD, ETC.

322 LEHIGH AVE., PHILA., PA.

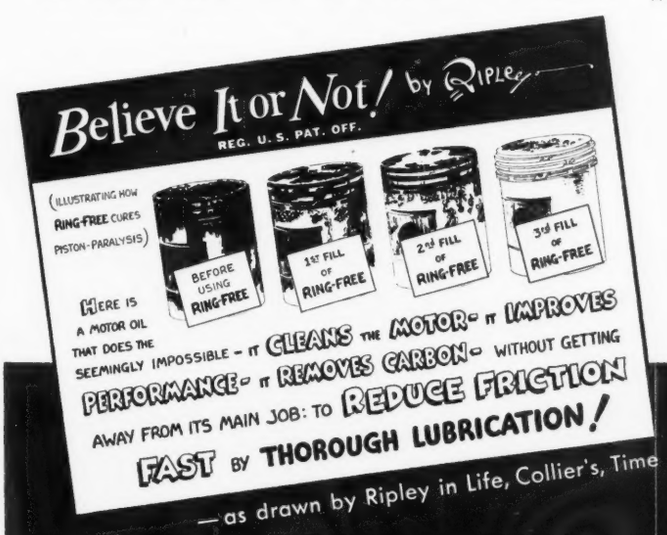
BELIEVE IT OR NOT!*—
"WE PRACTICALLY DOUBLED THE PERIOD BETWEEN OVERHAULS"
—SAYS LESTER G. MOSELY,

SERVICE MANAGER, BIBB COUNTY ROAD DEPT. SHOPS, MACON, GA.

"We made a test in a 35 Caterpillar Diesel Tractor... which was badly carboned up and consuming 16 quarts of oil per 10-hour shift. Immediately, thereafter, there was a noticeable increase in power and a gradual decrease in oil consumption... to only 3 quarts per shift. Since that time we have used Ring-Free in all seven of our diesel tractors and have found that the period between overhauls has been practically doubled." Ring-Free is backed by many amazing case histories of carbon-removing and friction-reducing performance in diesels. Proof? Call the Macmillan Man or write direct.

MACMILLAN PETROLEUM CORPORATION

50 WEST 50TH STREET, NEW YORK • 624 SOUTH MICHIGAN AVENUE, CHICAGO • 530 WEST 6TH STREET, LOS ANGELES

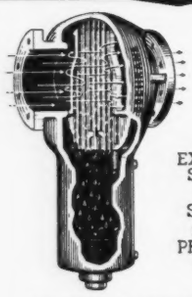

Believe It or Not! by Ripley
REG. U. S. PAT. OFF.
(ILLUSTRATING HOW RING-FREE CURES PISTON-PARALYSIS)
BEFORE USING RING-FREE
1st FILL of RING-FREE
2nd FILL of RING-FREE
3rd FILL of RING-FREE
HERE IS A MOTOR OIL THAT DOES THE SEEMINGLY IMPOSSIBLE - IT CLEANS THE MOTOR - IT IMPROVES PERFORMANCE - IT REMOVES CARBON - WITHOUT GETTING AWAY FROM ITS MAIN JOB: TO REDUCE FRICTION FAST BY THOROUGH LUBRICATION!
—as drawn by Ripley in Life, Collier's, Time

MACMILLAN
RING-FREE
MOTOR OIL

*Reg. U. S. Pat. Off.

Copyright 1941 by Macmillan Petroleum Corporation

Use **COCHRANE**
SEPARATORS & PURIFIERS
to remove oil and moisture from steam and air

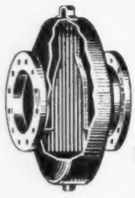


For EXHAUST STEAM
LIVE STEAM
COMPRESSED AIR

ALL-SERVICE SEPARATOR
For Horizontal Pipe Lines
For many years the most popular separator on the market. May be installed in restricted locations.

For EXHAUST STEAM
LIVE STEAM
COMPRESSED AIR

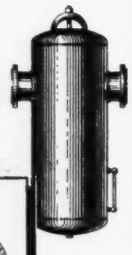
ALL-SERVICE SEPARATOR
For Vertical Down-Flow Pipe Lines
Highly practical efficient design. One-piece construction. Self-cleaning. Low in cost.



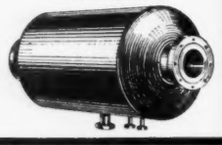
For EXHAUST STEAM
PROCESS STEAM
LOW PRESSURE LIVE STEAM

LOW PRESSURE SEPARATOR
For pressures up to 75 lb. Exceptionally large port area. Self-cleaning. Welded construction.

RECEIVER SEPARATOR



PURIFIER



COCHRANE CORPORATION
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COCHRANE

Cochrane Corp., 3106 N. 17th St., Phila., Pa.
Please send me copies of your Publications on Cochrane Separators and Purifiers
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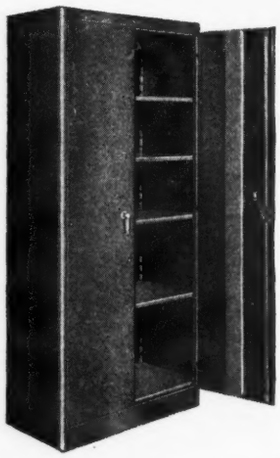
Firm _____
Address _____
City _____ State _____

etc. Sealing rings can be installed on old or new bent-tube boilers. Metal sleeves, shown in illustration, permit endwise movement of drums without pressure against walls. Flanges on drum sleeve prevent air seal packing from working inward into furnace, while flanges on metal rings prevent outward thrust of tiles. *George P Reintjes Co, 2517 Jefferson St, Kansas City, Mo.*

Storage Cabinets

STEELART CABINETS feature streamlined, round-corner construction. Line includes both double-door and single-door storage, wardrobe and combination cabinets, etc. Maker says there are no sharp corners or edges, and no exposed bolt heads on front



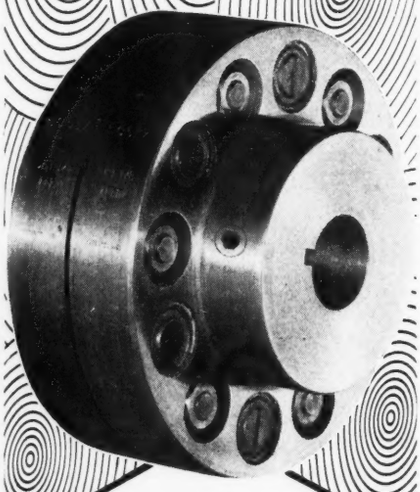
or sides. Closed bases are 4¾-in. high and doors swing open to 180 deg, allowing full capacity for storage. Top and bottom channels inside cabinet acts as door stops without projecting into storage area, while storage shelves are adjustable every 2 in. *Lyon Metal Products, Inc, Aurora, Ill.*

Liquid-Rubber Pulley Coating

NONSLIP "RUBBERPULL" is supplied in liquid form in convenient containers and is easily applied with brush to face of any pulley, flat or V-type, for purpose of preventing belt slippage. Product has rubber base and is compounded so that it sticks to pulley regardless of pull exerted. Can be applied in few minutes time at end of day, with pulleys ready for use in morning. *Nonslip Pulley Covering Co, 777 Hertel Ave, Buffalo, N. Y.*

Swing Check Valve

REGRINDABLE SWING CHECK valve is for 125 lb steam pressure at 500 F, or 250 lb non-shock cold oil, water or gas. Valve said to be suited particularly for condensate and return lines as well as for feed and oil-line service. Disk can be reground without removing valve from line. Body is extra strong, maker says, and is provided with ribs instead of customary hexagon. Made in sizes from ¼ to 2 in. *Jenkins Bros, 80 White St, New York, N. Y.*



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FLEXIBLE COUPLINGS

This is no time for shutdowns! Safeguard your production with Ajax Flexible Couplings! Their exclusive, rubber bushed, bronze bearings combine positive drive, resilient protection against misalignment, free end float, no lubrication problem, no noise, no backlash. Sizes from ½ inch bore up. Write for catalog.

Sales Offices in all principal cities . . . Look for Ajax in your phone book.

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FLEXIBLE COUPLING CO.
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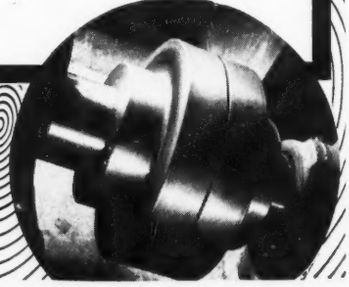
All the horsepower goes through this Ajax Coupling in the main power drive of a large flour mill as shown below.



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Executive Offices
230 Park Avenue
New York

C. Donald Dallas
President

To American Industry:

Virtually the whole production of Revere Copper and Brass today is directed toward arming the nation and the allies of democracy beyond its borders.

We do not make tanks or ships, fighting planes or machine guns. But without the products we do make, these would be useless. Every bullet, every shell and every cartridge needs copper or brass or the other copper base alloys——so do torpedo heads and army field kitchens——condensers of battleships and oil coolers of fighting planes.

It is our first task to insure an unfailing supply of metal products vital to defense.

In addition to this grave <u>new</u> responsibility, we recognize our long established responsibility to our old customers. And so we are gearing our defense tasks to allow the best possible production for <u>non-defense</u> too. But there are many cases where it is not possible to do both.

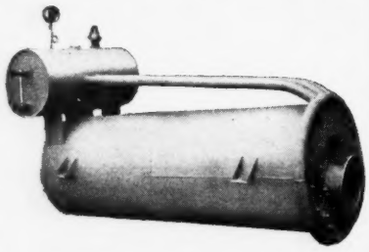
Revere, however, has always rendered service to its customers beyond the mere supplying of metal. And, even though we may not be able, in some cases, to supply the metal you ask for, we would still like you to call for these services——to use, at no cost or obligation, our vast file of data on copper and its alloys and our Technical Advisory staff. It may be that we can cooperate with you in suggesting ways for you to replace metals or alloys needed for defense by other metals or alloys, equally efficient and immediately available.

Sincerely yours,

C. Donald Dallas

C. Donald Dallas

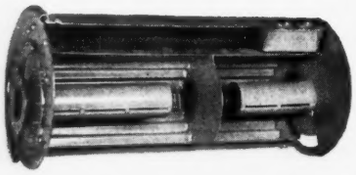
MAXIM



WASTE HEAT BOILERS

make waste exhaust heat pay its way!

Why let valuable exhaust heat slip away when you can put it to work for you to make hot water or steam? Investigate the efficient new Maxim method of combining efficient silencing, (and when necessary, positive spark arresting) with the conservation of waste heat. Find out how a Maxim Waste Heat Boiler can save money for your organization.



SEND THIS COUPON FOR DETAILS

THE MAXIM SILENCER COMPANY
92 Homestead Ave., Hartford, Conn.

Please send details on your waste heat unit ☐for hot water ☐for steam.

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Company.....

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City.....State.....

Southern Engineers

(*Continued from page* 122)

in Richmond to permit blending various coals in required proportions on their way to the bunkers. Observations of performance convinced operators that blending was entirely feasible and that excellent results could be obtained. Comments from several present applauded the attitude of the operating company in investigating this subject, since results of this kind can only be obtained in actual field trial by cooperative effort between mine operator and utility, while the results are thereafter available to all.

The highest-powered Francis wheel in the eastern part of the country is to become part of the TVA installation at Hiwassee, stated G R Rich and J F Roberts of Knoxville, Tenn. The new units have a rated capacity of 80,000 hp at 190-ft head whereas the Norris units, of the same physical dimensions, can turn out 66,000 hp at 165-ft head. Two 60,000-kw steam units will go into operation this fall, they added, at Watts Bar to prime-up the high-grade secondary hydro generation. Total steam capacity of the TVA, it was reported, will amount to about 300,000 kw when Watts Bar becomes available.

Cyclones for Separation

Separating liquids from vapors, an important step in many industrial processes, can be accomplished in various types of cyclones, summarized Arthur Pollak and L T Work. The principal source of entrainment, they stated, is wall creep of liquid in the cyclone, impelled by the vapor velocity. A complete bibliography, part of this paper, furnished background for those faced with a separation problem.

Many years of successful operation of mercury-vapor power plants were cited by W LeR Emmett, father of the mercury-vapor cycle, as evidence that binary-fluid cycles were practical from an operating standpoint. Cost of the porcupine-tube boiler, he opined, was much too high, and further development of the Pittsfield boiler, having long vertical wall tubes and small cubical size, represented the best direction for future experimentation. It is not necessary, he said, to fill the entire tube space with mercury, as enough liquid can be entrained to wet the tube walls. This property of the mercury boiler can be employed to reduce considerably the quantity of mercury required with consequent reduction in initial investment.

WHAT "TOUGH" Packing Job Have You?

TRY "AMBEST"

A universal packing for all rods in good condition—made from long pliable strands of anti-friction metallic alloy—suitable for all pressures and temperatures up to 550°. Will not scratch the finest rod. Single supply will allow packing engine and pump rods, compressors, valve stems, etc.

For Worn or Scored Rods

"Eureka" Oval Gum Core can be used on any rod (except high pressure steam) and will give better and longer service. Is oval and soft—conforms to the rod—permits more rings in stuffing box—recommended for steam, air, gas and ammonia.

Write for working sample and our catalog No. 22

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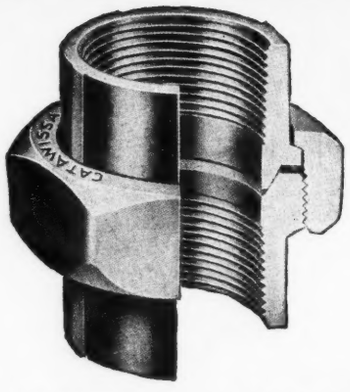
CATAWISSA



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Hot Forged From Solid Steel Bars

The forging process further refines the steel in Catawissa Unions and enables them to withstand years of shock and vibration. Seats, Steel to Steel, STAINLESS STEEL to Steel or Bronze to Steel are carefully hand ground, require no packing and are set on a 55° angle with a flat surface contacting a ball surface. This insures a perfect seal even though pipe is out of line . . . . Write for complete data and prices.

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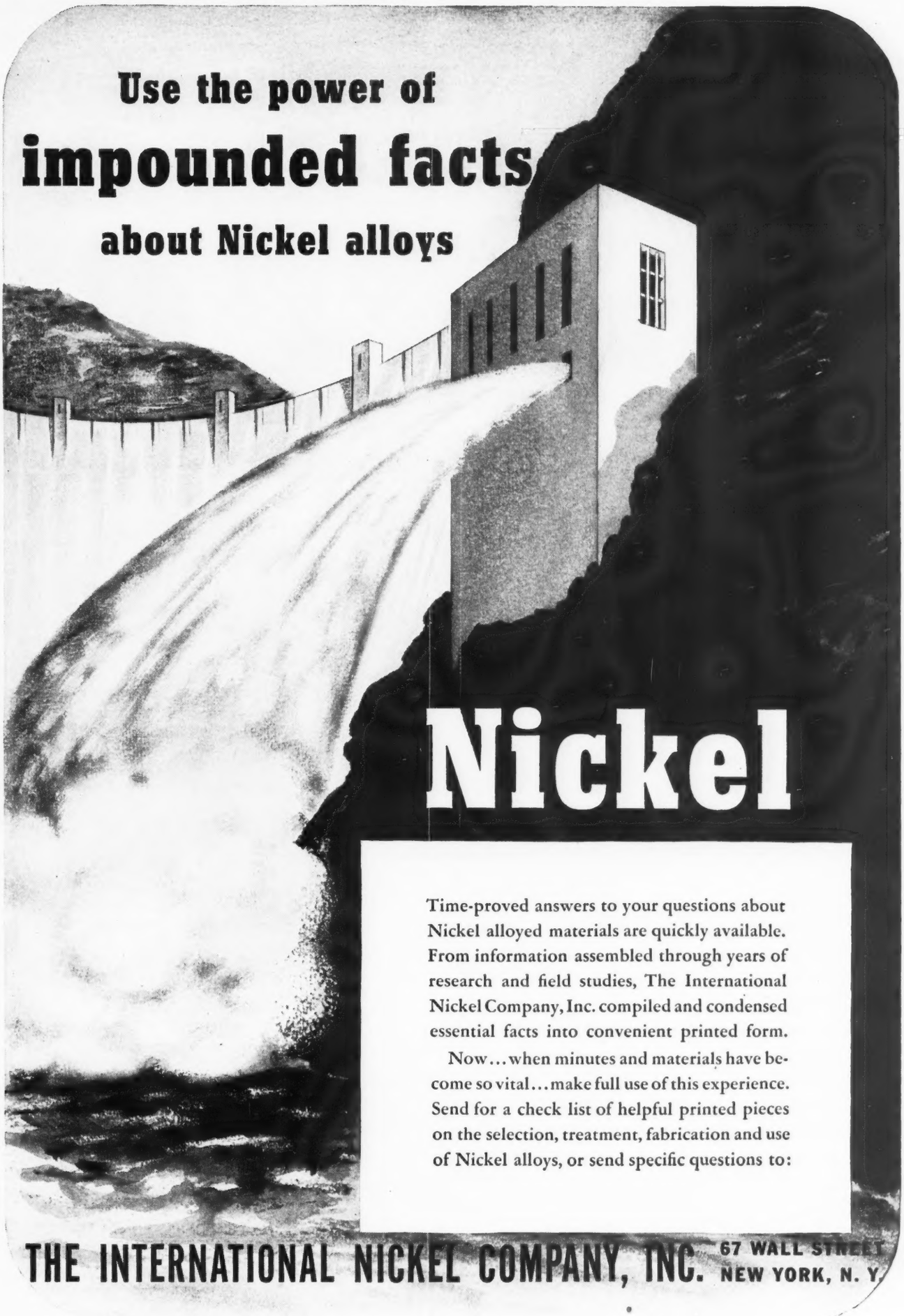
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Time-proved answers to your questions about Nickel alloyed materials are quickly available. From information assembled through years of research and field studies, The International Nickel Company, Inc. compiled and condensed essential facts into convenient printed form.
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Do you pack with flax?

Here's a tip to engineers who have been packing water pumps with flax . . . .

and find the supply running low because of the war.

. . . . . Use PALCO* the cotton packing specially lubricated for water service, with lubricant in every strand

FREE WORKING SAMPLE OF PALCO*

If you are having trouble with packing on any service, give our packings a real test . . . without cost. Send us your name and address for free working sample, stating the size and service.

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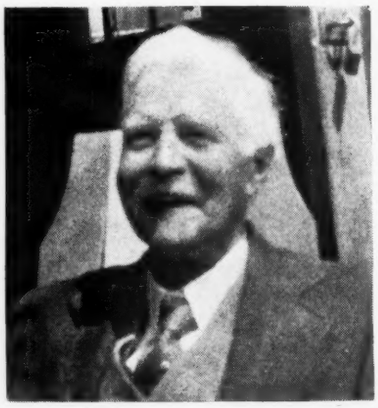
Power Lines

Robert Grimshaw, First POWER Editor, Passes Away

Dr Robert Grimshaw, 91, first editor of POWER, and internationally known consulting engineer and inventor, died April 9, at Englewood Hospital, New Jersey.

Dr Grimshaw was born in Philadelphia and was graduated in 1869 from Andalusia College, near Philadelphia. His first job was a shop worker and draftsman at an iron works and shipyard near Chester, Pa. He opened an office as a consulting engineer in 1873. Many of the engineering improvements Dr Grimshaw suggested were far in advance of his times and were ridiculed. In 1883 he designed a locomotive which



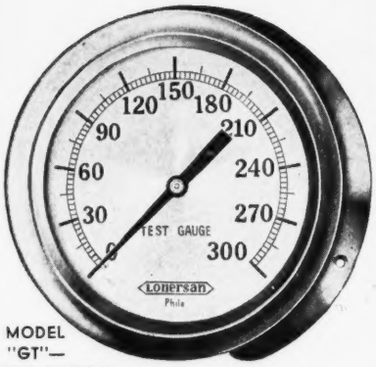
Robert Grimshaw

he said could make an 18-hr run from New York to Chicago. Engineers scoffed and called the engine "Grimshaw's double-ended wheel-barrow," but within ten years locomotives built to his specifications were in use. He also suggested in 1901 the possibility of developing sound motion pictures by using a sound track on the edge of regular films. He could not get the financial backing necessary to develop the idea, so abandoned it. Years later he worked with the American Foundation for the Blind in developing the so-called "talking book."

He was a prolific writer on engineering subjects, and was a consultant to many of the largest industrial firms in the United States, to the War, Navy and Treasury Departments, and to several foreign governments. In his sixty years of engineering he perfected many technical improvements for railroads, foundries and other metal-working plants.

When he retired at 82, he began to devote his time to the preparation and

Check on Gauges!



MODEL "GT"— TEST GAUGE

USE IT FOR CALIBRATING AND TESTING OTHER GAUGES or for ANY SERVICE WHERE THE GREATEST ACCURACY IS REQUISITE ★

These test gauges are made with the utmost care—we guarantee them for delicacy of action and finest workmanship. **J. E. LONERGAN CO., Race and Second Sts., Philadelphia, Pa.**

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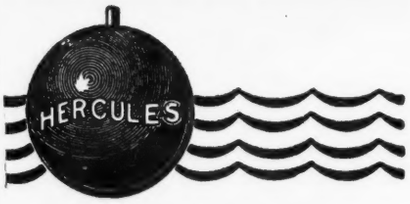
VALVES • GAUGES • SPECIALTIES
300 Specialties For Power Plants • Since 1872

HERCULES
Seamless Copper
FLOATS



GUARANTEED TO STAND UP!

Every Hercules Float carries our guarantee to stand up under 350 lbs. working pressure and 500 degrees temperature.

Fabricated of seamless copper under our special spinning process. Hercules Floats are uniform in thickness and high in mechanical strength.

You can depend on Hercules for floats—in standard shapes up to 10 in. and in special types to your specifications—to give long, dependable, economical service.

Insure care-free maintenance of water level in your heaters, tanks, reservoirs and other equipment by specifying "HERCULES."

HERCULES FLOAT WORKS
200 Franklin St.
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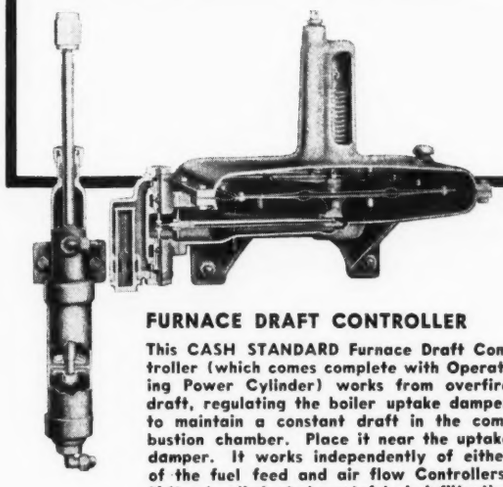
BOOST BOILER ROOM *Performance*

AND CUT OPERATING COSTS IN DOING IT ! ! !

CASH STANDARD

AUTOMATIC COMBUSTION CONTROL

is not a costly investment



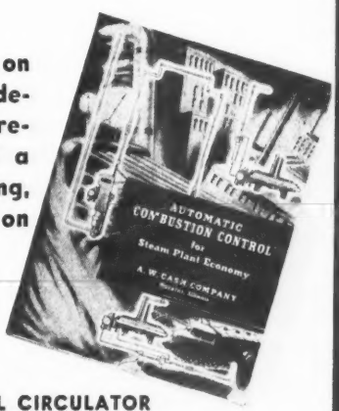
FURNACE DRAFT CONTROLLER

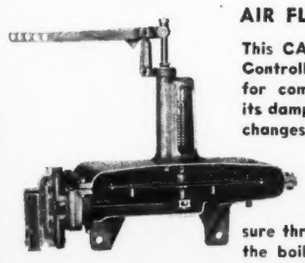
This CASH STANDARD Furnace Draft Controller (which comes complete with Operating Power Cylinder) works from overfire draft, regulating the boiler uptake damper to maintain a constant draft in the combustion chamber. Place it near the uptake damper. It works independently of either of the fuel feed and air flow Controllers. If it only eliminated wasteful air infiltration it would be a profitable investment.

Get the most out of your boiler room by applying CASH STANDARD Automatic Combustion Control — make such important savings as in fuel costs and in maintenance — get more steam even though you burn less fuel — hold your steam pressure within close limits — get dependable boiler room control that saves detail on the part of operators and gives them more time to do other important duties.

There are numerous types of CASH STANDARD Systems of Automatic Combustion Control. They are varied according to the necessities of plant requirements. Regardless of the kind of fuel you burn or the size or type of your boiler or furnace, you can secure a dependable CASH STANDARD Automatic Combustion Control System to give you lower boiler room operating costs. Units for a complete system can be purchased for as little as $290.

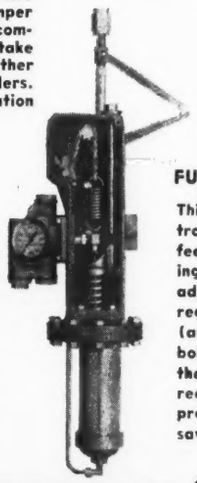
Read in Bulletin No. 300 complete details on CASH STANDARD systems specifically designed to meet every requirement — whether you have a stoker, pulverizer, oil-burning, or gas-firing equipment on your boiler.





AIR FLOW CONTROLLER

This CASH STANDARD Air Flow Controller meters the air needed for combustion. Install it near its damper. It is not affected by changes in fuel bed resistance or any other variables, because it meters air supply according to the differential pressure through the gas passages of the boiler, doing its part to insure perfect combustion.



FUEL FEED CONTROLLER

This CASH STANDARD Master Controller automatically regulates fuel feed. Locate it conveniently. Working from boiler pressure, it will adjust the rate of combustion by regulating the rate at which fuel (any kind of fuel) is supplied to the boiler furnace. And it will adjust the Air Flow Controller so the correct amount of air is supplied for proper combustion — hence, money saving.

OIL CIRCULATOR

The purchase of this oil circulator is optional. All three Controllers shown above can be properly operated by clean water, but it is preferable and cheapest in the long run to operate with this CASH STANDARD Oil Circulator — price $108. equipped with 110-220 v. 60 cy. motor.

A. W. CASH COMPANY
DECATUR, ILLINOIS

CASH STANDARD
CONTROLS . . VALVES

With VIKING 3's NOT a CROWD

With every Viking installation you save valuable plant floor space. That's because all Viking Rotary Pumps are simple in principle (only 2 moving parts) . . . a compact design makes it possible to neatly fit more Viking Rotary Pumps into less space without crowding. There are no space-wasting features, no springs or tricky gadgets . . . every pump is ALL pump. With plant floor space at a premium today, this is a mighty important factor. For greater pumping economy, for neater, space-saving installations, equip your plant with Viking.

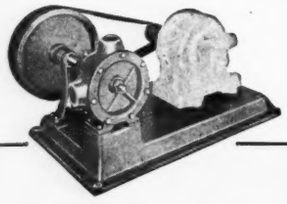


Figure 53

V-belt motor driven unit.

Furnished in iron, bronze-fitted or all bronze construction.

Available in capacities from 5 to 1050 GPM.

Belt guard is furnished as standard equipment.

VIKING PUMP CO.

CEDAR FALLS, IOWA

distribution of Braille literature for the blind. As a result of a conversation with a blind Negro, who told him of the shortage of literature for the blind, Dr Grimshaw founded Blindaid, an organization of volunteer workers throughout the country. These workers prepare copies of news reports, books and magazines in Braille for distribution to the blind.

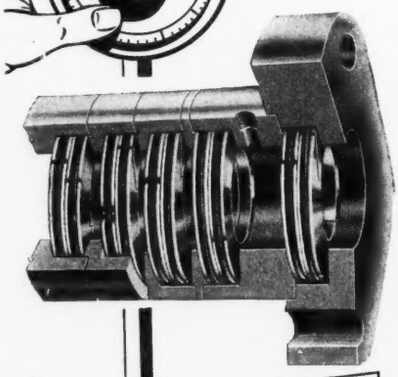
Dr Grimshaw was one of the 17 men who founded the American Society of Mechanical Engineers in 1880. He was also founder of the Polytechnic Society of Greater New York, a former president of the James Watt Association of Stationary Engineers, and a member of many other technical societies. Of his many books and publications, probably the best known is "The Locomotive Catechism," which has gone through 30 editions since 1888.

Predicts More Hydrogen Cooling

"In view of the growing acceptance of hydrogen-cooled generators by the industry, the future will see not only the continuous application of hydrogen cooling to generators in the larger sizes, but in smaller sizes as well, according to D S Snell of the General Electric Turbine Engrg Dept. This prediction was made in a review of "Progress in Design and Operation of Hydrogen-Cooled Generators" which he presented at a meeting of the Missouri Valley Electrical Association at Kansas City, Mo., on March 27.

Tracing the rise of the use of hydrogen for cooling purposes, Snell pointed out that the first hydrogen-cooled generator was placed in service on October 1937 at the Dayton Power and Light Co. Since then more than 40 units, with a combined capacity exceeding 1¾ million kw, have been placed in operation in the United States. During the past two years, 70% of the total kw of generators ordered from General Electric have been of the hydrogen-cooled type. After describing several representative installations, Snell presented the service record of all General Electric units of this type now in service. He also described several construction features about the generators. He stated that the most important single construction feature of hydrogen-cooled generators is the arrangement for sealing the rotating shaft against the outward leakage of hydrogen and the inward leakage of air. This is accomplished by an oil-film type of shaft seal into which vacuum treated lubricating oil is supplied under pres-

The number of Pairs of Wearing Rings Depends on the Amount of Pressure to be Held



The Accurate Packing COMBINATION for High Pressure Jobs

For nearly half a century, France "Full-floating" Metal Packing has proved its stamina, its ability to keep on giving service long beyond a "reasonable expectancy." It is the accurate packing combination (full-floating rings in a metal case) for the efficient sealing of compressor, engine and pump stuffing boxes regardless of pressure, temperature, vapor or gas conditions.

Constructed of few parts. Simple to install, inspect or clean. The type illustrated can be provided with a vent connection in addition to a lubrication connection, if desired.

For longer service and lower operating costs, specify FRANCE, the accurate packing combination that *l-a-s-t-s*. Write for Catalog M-7.

THE FRANCE PACKING COMPANY

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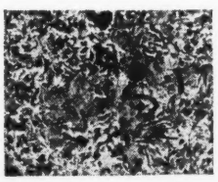
Original **FRANCE METAL PACKING**

"DARLINGS FOR NEARLY A THIRD OF A CENTURY"

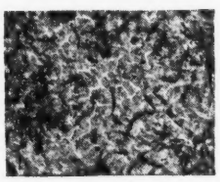
INDIANAPOLIS WATER CO.

Leading users everywhere have been won completely by the really better performance that goes with Darling "dense-metal" construction.

Don't mistake "dense-metal" for just a phrase. It's a mighty important structural advantage. From the unique Darling design, with its smooth curves and uniform sections . . . through careful foundry technique, accurate molding, proper gating and heading . . . every step is directed towards a smooth, close structure which we call "dense-metal". Darling "dense-metal" results in better machining, more accurate threading, and freedom from flaws or shrink. Get these benefits in your next installation. Specify Darlings!



Photomicrograph (mag. 100x) showing the structure of a typical sample of cast iron as ordinarily produced. Note the entrained inclusions tending to break down the strength of the metal and produce leaks.



Shows the structure of Darling Dense-Metal gray iron. In this dense, fine, homogeneous grain structure the shrinkage porosity has been minimized, with resultant pressure tightness, strength and better resistance to abrasion and corrosion.

DARLING VALVE & MANUFACTURING CO.

Williamsport, Pa.

Representatives in:

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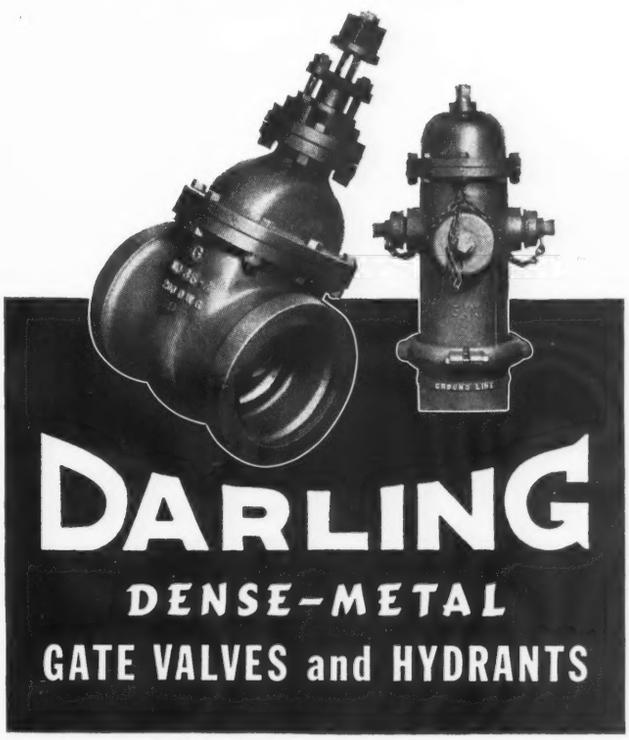
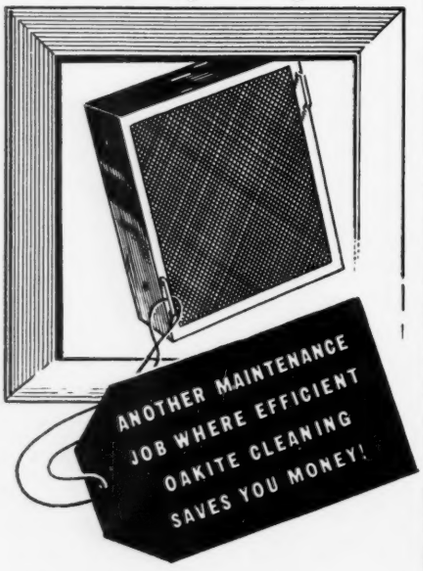


Do You Clean AIR FILTERS This Easy Way?



Plant after plant has found by experience that the most effective way . . . the **EASIEST** way . . . to clean filters quickly is to use Oakite materials.

Whether your filters are of the dry type or the **VISCOUS** type . . . whether the filtering medium is of metal shavings, split wire, ferrules, glass wool or expanded metal . . . vigorous but **SAFE** Oakite detergent action successfully routs trapped dust, dirt, lint, soot and other accumulations in a jiffy . . . leaves the unit clean and ready for immediate re-use

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Packed with helpful information on proved, money-saving, safe Oakite methods for cleaning Diesels, oil coolers, stripping transformers, steam cleaning, this 20-page booklet is yours **FREE** for the asking. Write today!

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OAKITE *Certified cleaning*
MATERIALS & METHODS FOR EVERY CLEANING REQUIREMENT

sure. Other features described were the gas control system and the hydrogen control cabinet, housing the gages and instruments for operation of the generator in hydrogen.

War Department Warning

A War Department warning has been issued against alleged coercive methods used to solicit advertising from firms holding Government defense contracts, on the part of publications which seek to assume a quasi-official connection with the Department. This announcement came as the result of a complaint from a manufacturing firm that a periodical with offices in a southwestern city had solicited its advertising through a letter creating an impression of military connections which were imaginary. Existing excellent relations between the War Department and defense industry might be threatened by such practices.

BC Power Co Plans Additional Capacity

Due to increasing demand for electric power for war industries, it is reported that the British Columbia Electric Co may proceed with its power development scheme in the Bridge River. This development scheme was started more than 10 years ago at Bridge River, at which time the company spent some $3,000,000 on a 13,200-ft tunnel, then temporarily suspended work on the project when the depression cut down power requirements. In addition to the completed tunnel, the project includes a penstock 2200 ft long, with an ultimate effective head of 1300 ft, a temporary diversion dam 40 ft high, and ultimate combined diversion and storage dam at the tunnel intake 185 ft high and 3 storage dams 190 ft, 165 ft, and 45 ft high respectively, at points higher up the river,

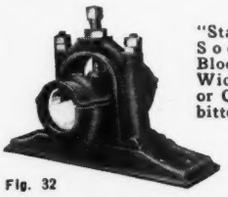
Coal Researchers Discuss Projects

At the invitation of Howard N Eavenson, president, Bituminous Coal Research, Inc., the directors of the leading coal research laboratories of the country met at Battelle Memorial Institute, Columbus, Ohio, March 25, in the first of a series of conferences planned by Bituminous Coal Research to insure correlation of the activities of those conducting research on coal. Battelle was selected for the initial meeting so that the directors might become acquainted with the program of research being conducted at the Institute by Bituminous

"STANDCO" PILLOW BLOCKS

Fig. 1635

Combining clamp block and pillow block requirements in one type, the "Standco" shown above is sturdily built and is offered in a wide range of sizes. Babbitted bearing surfaces are finished beautifully smooth, both faces machined. It can be depended on for long, trouble-free service.



"Standco" Ball and Socket Pillow Block, Ring or Wick Oiling, Plain or Collar End Babbitted Bearings.

Fig. 32

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No need to walk or climb "close-up" to a WESTON Thermometer to get your reading. The large, gauge-type dial is always in plain view . . . easily read from a distance . . . even when mounted on overhead lines, or in adverse light conditions. Thus they save steps, save time, and insure more accurate readings. Another outstanding advantage is their rigid, all-metal construction . . . which keeps breakage at a minimum and eliminates damage from overloads. Available in angle and straight stem types, and in sizes and ranges for most power plant needs. Bulletin giving complete details available. Write to . . . Weston Electrical Instrument Corp., 679 Frelinghuysen Avenue, Newark, N. J.

WESTON
GAUGE-TYPE THERMOMETERS

K&M PIPE INSULATION PROTECTS FINE WOOLENS AGAINST SPOILAGE IN LEADING TEXTILE PLANT

Washing department in large Eastern textile plant, showing the cold water lines running above the washers. These lines are insulated against corrosion and condensation alike with Keasbey & Mattison materials. Material was applied by Mundet Cork Corp., approved K&M Distributor in Brooklyn, N.Y.

In addition to its normal duty of saving heat and fuel, K&M insulation often performs unusual money-saving functions. An important instance of this sort occurred in a large Eastern textile plant where fine woolens are manufactured.

Cold water lines run above the textile washers in a fume-filled room where the temperature is 85° and the humidity stays high. It is easy to see what would happen if some sure way were not found to protect the cold water lines against corrosion and condensation. Rusty water would drip on fine woolen piece goods. Stained textiles are spoiled textiles. This danger had to be absolutely eliminated.

Keasbey & Mattison engineering devised the method, and Keasbey & Mattison insulation materials supplied the means of protecting the cold water lines against fumes, heat, and moisture alike. The result is a pipe line that neither corrodes nor drips, and textiles that are safe against rust stains.

The line of Keasbey & Mattison asbestos and magnesia insulation products is complete, and is specialized for the needs of each plant. K&M engineers, working with K&M Distributors strategically located throughout the country, can point the way to real savings in your plant, too. Write Dept. 11 for full details.

KEASBEY & MATTISON
COMPANY, AMBLER, PENNSYLVANIA

DIXON'S Pipe Joint Graphite Compound and Dixon's Graphite Seal make joints that are permanently sealed, but never stuck. Wipe a little on every threaded, flanged, or gasketed joint for easy disassembly 10 days or 10 years hence . . . and a perfect seal in the meantime.

Dixon's Pipe Joint Graphited Compound seals against water, steam, air, acids, alkalies, brine, and all aqueous solvents.

Dixon's Graphite Seal seals against gasoline, oils, and all non-aqueous solvents.

You can't beat this big red bar of Dixon's Solid Belt Dressing for making belts grip better *and* last longer. No need to shut down—just hold end of the bar against *running* belt. Peel off cardboard wrapper as dressing is used. Perfect for *all* belts—leather, rubber and composition.

Order from your usual supplier or write Dept. D-94.

AND WHAT A BIG HELP THESE ARE

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DRY GRAPHITE LUBRICATION FOR LOCKS AND A 1000 OTHER USES—SQUEEZE 'EM
DIXON'S FLAKE GRAPHITE
DIXON'S CUP GREASE

JOSEPH DIXON CRUCIBLE CO.
JERSEY CITY NEW JERSEY

327

Coal Research. In reviewing the history of Bituminous Coal Research, Mr Eavenson pointed out that it is sponsored by the National Coal Association and obtains its financial support by voluntary contributions from that organization, local associations, individual producers and coal-carrying railroads. In a round-table discussion, each director reviewed in some detail the general type of research and specific projects under way in his laboratories at present.

The men who attended the session are: A P Krantz, research professor, Department of Mechanical Engineering, University of Illinois, Urbana, Illinois; R A Sherman, supervisor, Fuels Div, Battelle Memorial Institute; Mr Eavenson; Clyde E Williams, director, Battelle Memorial Institute; J E Tobey, chairman, Technical Advisory Board, Bituminous Coal Research, Inc, Cincinnati, Ohio; H H Lowry, director, Coal Research Laboratory, Carnegie Institute of Technology, Pittsburgh, Pennsylvania; E R Kaiser, fuel engineer, Battelle Memorial Institute; M M Leighton, chief, Illinois State Geological Survey, Urbana, Illinois; C E Lawall, president, West Virginia University, Morgantown, West Virginia; J L Bray, School of Chemical Engineering, Purdue University, Lafayette, Indiana; H H Storch, supervising chemist, U. S. Bureau of Mines, Pittsburgh, Pennsylvania; F W Godwin, Armour Research Foundation, Chicago, Illinois; A W Gauger, director, Mineral Industries Research, Pennsylvania State College, State College, Pennsylvania; and B A Landry, fuel engineer, Battelle Memorial Institute.

US Leads World In Hydro Horsepower

The United States led the world at the end of 1940 in the horsepower capacity of water wheels in water power plants, the Geological Survey of the United States department of the Interior reported recently. With an installed capacity of 19,000,000 horsepower in water wheels, this nation had more than twice as much water wheel power as Canada, in second place. Canada was rated as having 8,584,000 horsepower, with Italy in third place with 6,250,000.

The total capacity of water wheels in power plants throughout the world was 69,400,000 horsepower at the end of the year, the Survey said The Geological Survey pointed out that there has been an increase of about 1,800,000 hp in the capacity of water power plants in the Western Hemisphere since 1938. At present, in the United States and Canada alone, there are under way power

WHY DO YOUR FURNACE LININGS BREAK DOWN?

It is a proven fact that spalling or loosening of the brick is the cause for 85% of the breaking down of fire brick constructions. This means that greater length of service can be secured and considerable savings can be made in cost of materials and labor needed for rebuilding by using a fire brick cement with a high bonding strength. Our belief that Adamant met these requirements led us to have impartial laboratory tests made by a leading technical institute. Modulus tests were made on 5 test joints . . . these showed

ADAMANT
FIRE BRICK CEMENT has a BONDING STRENGTH
of 800 lbs. per sq. in. at room temperature. 1270 lbs. per sq. in. at 2600° F

ADAMANT has a P.C.E. of over 3,000° F.

These figures show why so many firms prefer Adamant, the cement that makes the joints as strong as the brick they bond. Write for full details.

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Makers of ADAPRODUCTS, Swanson & Clymer Sts., Philadelphia, Pa. In Canada, Canadian Botfield Refractories Co., Ltd., 171 Eastern Ave., Toronto.

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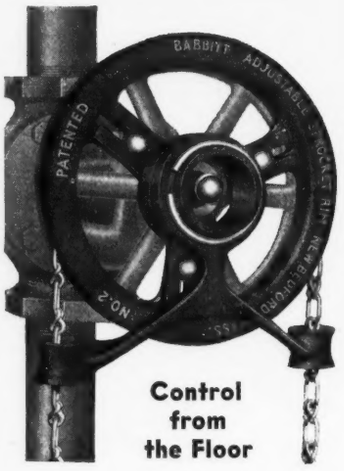

Control from the Floor

With the Babbitt Rim for Valves you eliminate danger and banish the step-ladder. You can now place your valves wherever they come economically and conveniently. They fit any valve. Let us tell you more about them. Write today.

BABBITT STEAM SPECIALTY CO.
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"IT SAYS THEIR LIMITORQUE CONTROLS MORE THAN FILL OUR CLAIMS"
"WELL, IT'S ONE MORE POWER COMPANY TO JOIN THE LONG LIST OF SATISFIED USERS"

Philadelphia LIMITORQUE CONTROL operates all types of valves, etc., safely, economically, from convenient stations.
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Satisfaction inevitably follows when Philadelphia Limitorque Controls are adopted for operating large or inaccessible valves. These controls quickly prove their economy and dependability in service where valves up to 96" in diameter can be operated at highest desirable speeds with perfect safety to the workmen and the valve mechanism. Limitorque functions simply by pressing a button at a conveniently located control station. The operating mechanism fits all types of valves in almost any position or location, and can be used on existing equipment. The list of Limitorque users includes the names of many of the country's leading Central Stations and private power plants. Write us today for more complete information.

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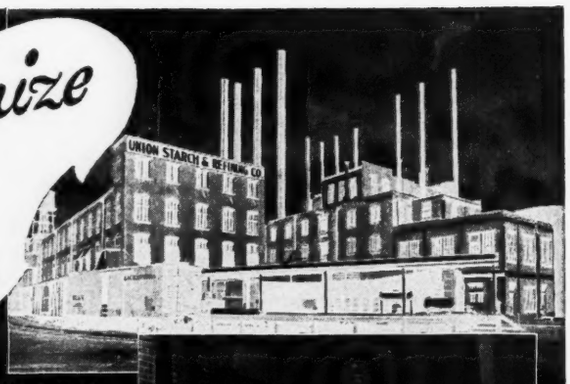

FOR the past 8 or 9 years The Union Starch and Refining Company of Granite City, Illinois, has had a constant problem on its hands to keep its steam generating equipment in pace with its increasing steam demand.

For 30 years steam requirements had been met by six 400 h.p. longitudinal drum boilers fired by natural draft chain grate stokers.

In 1932, in an attempt to meet the ever-increasing load, a changeover to natural gas was made to avoid installing additional boilers. By 1936 the load had increased to peaks of 160,000 lbs. per hour making it absolutely necessary to completely modernize the steam generating equipment.

The first step was the installation of a four-drum Stirling type steam generator at 60,000 lbs. per hr. continuous steaming capacity with 75,000 lbs. per hr. peaks guaranteed for four hour periods. This unit has a nominal rating of 800 h.p. As fast as possible two additional units identical with the first were installed and all were placed under automatic operation through the medium of a Hays Combustion Control System. The control panel for one of the units is shown above.

The Hays system of automatic combustion control holds the steam pressure right on the line in spite of the widely fluctuating load, steaming at times as much as 25,000 lbs. per hr. in excess of its guaranteed 75,000 lbs. per hr. capacity. At the same time a virtually constant CO_2 in excess of 12½% is maintained as well as a constant furnace draft. The fact that all three of these new units are Hays equipment is mute evidence of satisfaction.

Hays engineers will be glad to advise how instruments and control may be applied to your steam generating problems. Write us—no obligation.

ENGINEERS PLEASE NOTE:
Tear off the bottom of this ad and mail with your name and address to The Hays Corporation for copy of "Automatic Combustion Control and its Relation to Lower Steam Costs."

The HAYS CORPORATION
SINCE 1903 COMBUSTION INSTRUMENTS AND CONTROL
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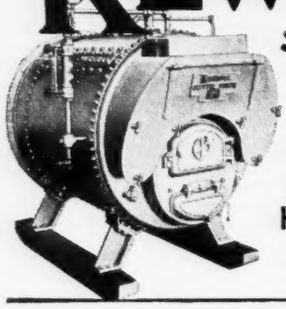
☆ HIGH-PRESSURE STEAM.. AT LOW COST!

KEWANEE

SCOTTIE JUNIOR BOILER



Five sizes . . . conveniently compact, yet easily accessible . . . most economical in first and operating costs. A fuel saver. May be purchased on easy payments under FHA terms thru our Finance Corp.

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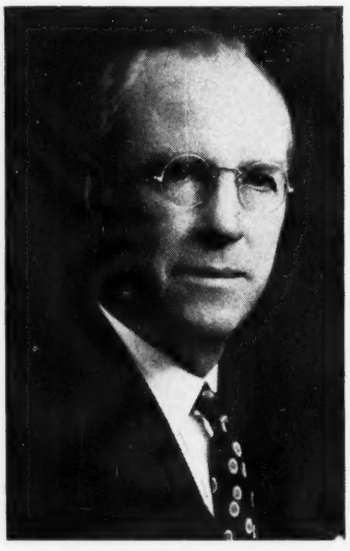
projects totaling more than 8,000,000 hp. Many of these require only the installation of water wheels on foundations already built, or the installation of additional units at plants already in operation.

Knight and Wellington Advance to New Posts

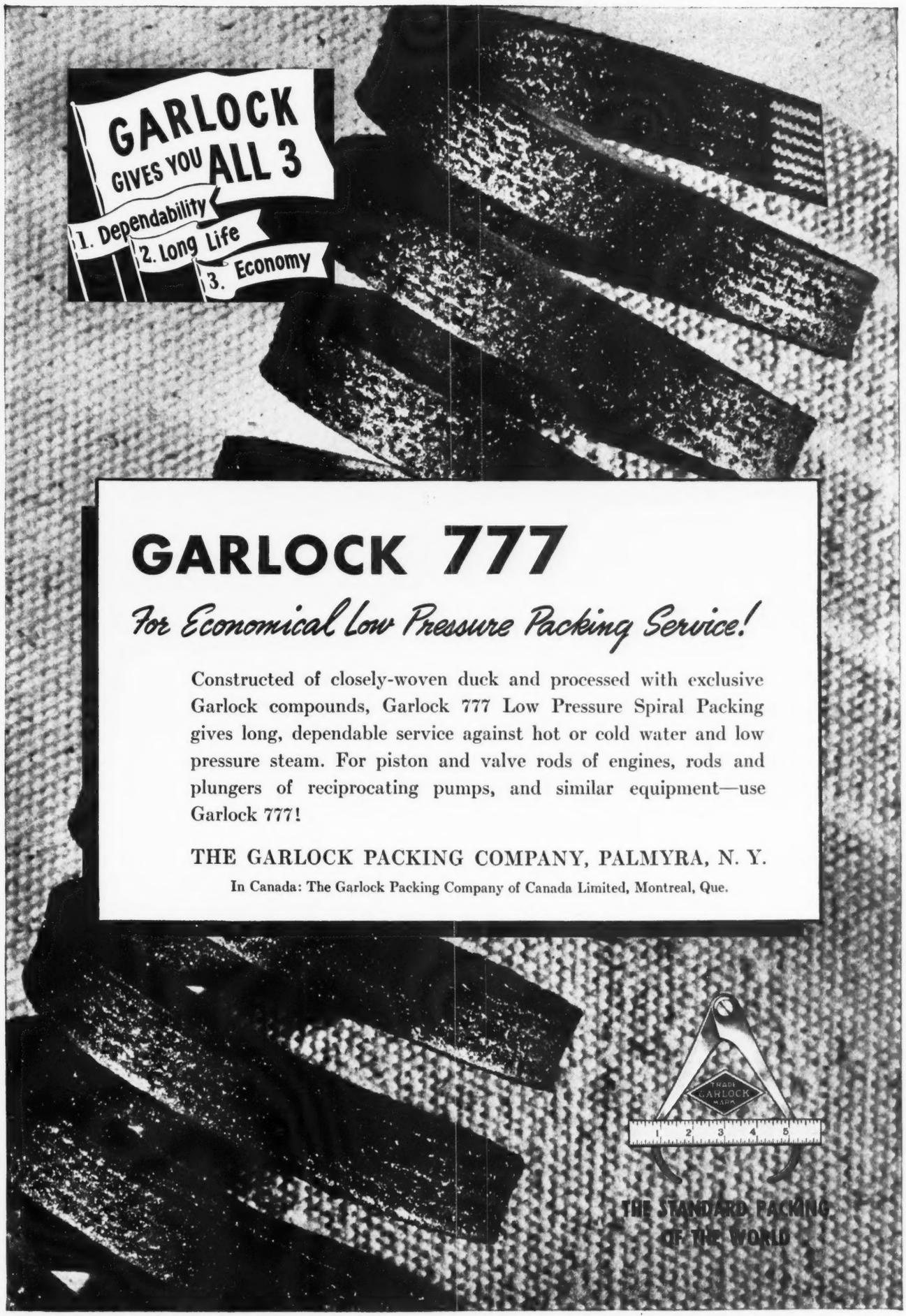
Fred D Knight, superintendent of the production department of the Boston Edison Co since 1937, resigned April 1 to accept the post of assistant to the operating vice-president of the Hartford Electric Light Co. Mr Knight re-



Fred D Knight

turns to the scene of his former work, having been in charge of the construction of the South Meadow station at Hartford for the Stone & Webster Engineering Corp, with which organization he spent 16 years on major projects throughout the country. He is a native of Limerick, Me., and was graduated from the University of Maine in 1909.

H W H Ellington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Constructed of closely-woven duck and processed with exclusive Garlock compounds, Garlock 777 Low Pressure Spiral Packing gives long, dependable service against hot or cold water and low pressure steam. For piston and valve rods of engines, rods and plungers of reciprocating pumps, and similar equipment—use Garlock 777!
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How much hot water is going into steam? . . . Are boilers working at top efficiency? . . . How much gas are we using each day? . . . Let a Simplex Meter give you the quick, accurate answers to these important plant flow questions.

TYPE M S METER

Simplex Meters can be used with any type of pressure producing device (orifice, nozzle, venturi tube) in any size of main to totalize the flow of Boiler Feed Condensate, Steam, Air, Gases and Corrosive Liquors. It is extremely accurate and reliable over wide ranges. And its modern price puts it within easy reach of every plant. Write for new descriptive bulletin.

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Prior to his college work he was employed for a year by the Boston Elevated Railway and for three years by the General Electric Co at Lynn, Mass. He joined Boston Edison in 1925 as assistant superintendent of production.

H W H Wellington has become superintendent of the Boston Edison production department, succeeding Fred D Knight. Mr Wellington has been with the company for about 23 years, beginning as a station operator. He is a native of Roxbury, Mass., and in his earlier career was employed in dam construction at Keokuk, Ia., and in the General Electric laboratory at West Lynn. In 1919 he became technical assistant to R E Dillon, now vice-president in charge of production and engineering, and in recent years has been assistant superintendent of production.

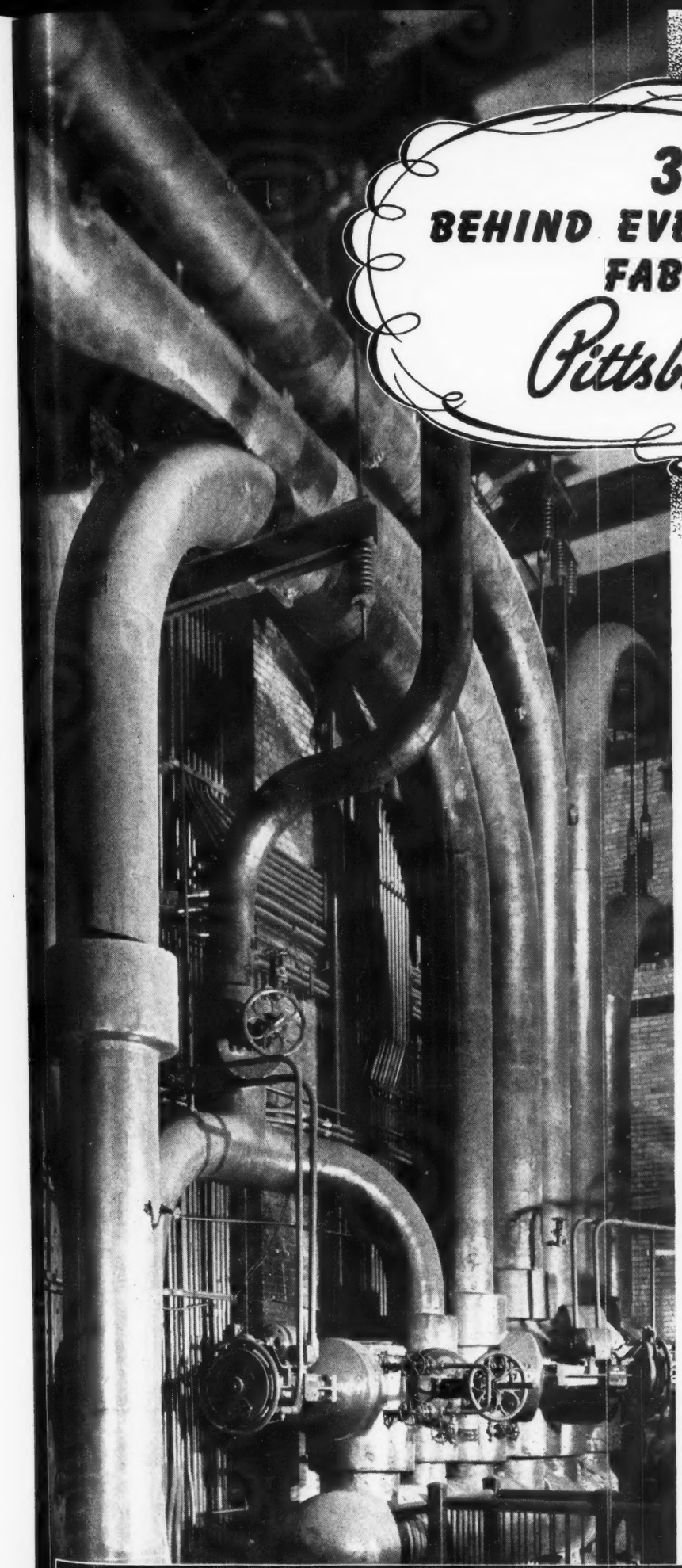
OBITUARIES

ARTHUR L FRERET, 64, of Birmingham, Ala., chief electrician of the Tennessee Coal, Iron and Railroad Co, died at his home there recently.

JOHN BRUTON, veteran stationary engineer, died suddenly at his home in Oil City, Pa., March 11. Born in England, he came to this country at the age of 21. He was employed for 17 years by the Oil Well Supply Co as stationary engineer.

RINALDO E MARTIN, superintendent of power stations of West Penn Power Co, passed away suddenly March 24 while attending a meeting of the West Penn Savings and Loan Association. Mr Martin entered the service of Wheeling Traction Co in 1914, and was assigned to the Wheeling power station as attendant in 1917. A year later he was transferred to the Washington station as engineer. From this post he moved to boiler repairman at the Connellsville power station, and in 1920 was sent to Springdale as combustion engineer. At Springdale he became chief engineer in 1921, boiler-room superintendent in 1924, and superintendent in charge of complete power plant activities in 1928. In 1930 he was made superintendent of power stations covering the entire system. He was a member of the Prime Movers Committee of the Pennsylvania Electric Co, the American Society of Mechanical Engineers, American Institute of Electrical Engineers and others.

ELMER E WOODWARD, president of the Woodward Governor Co, Rockford, Ill., died recently at the age of 78. After becoming an expert in ma-



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Pittsburgh Piping's engineering department is thoroughly familiar with the theoretical as well as the practical phases of design of modern power and process systems. This knowledge insures the correct interpretation of customer's drawings, strict compliance with the proper codes and efficient detailing of assemblies for economical fabrication.

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In the extensive Pittsburgh Piping Fabricating Shops are modern facilities for bending, welding, machining and all other fabrication operations. Modern gas fired furnaces are available for heat treating large assemblies. For stress-relieving circumferential welds, special automatic electric heating equipment has been developed. A well-equipped metallurgical laboratory constantly checks fabricating procedure and technique.

3 SPEEDY ERECTION

With large assemblies pre-fabricated in the shop to extremely close tolerances, field erection work is kept to a minimum. All shop work is coordinated with field requirements, and competent field supervision insures speedy erection and cooperation with other sub-contractors.

When contemplating your next piping program, get in touch with your nearest Pittsburgh Piping representative, listed below, for efficient, time-saving fabrication and erection.

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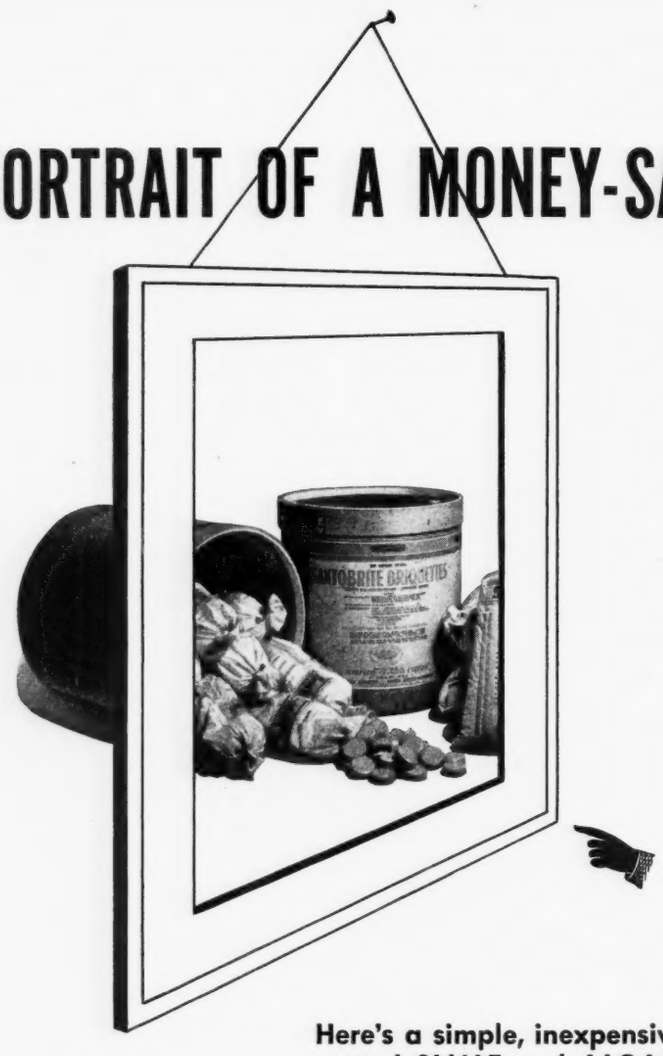
Union Guardian Building, Detroit
525 Market Street, San Francisco

PORTRAIT OF A MONEY-SAVER



Here's a simple, inexpensive way to control SLIME and ALGAE in your cooling water system!

If you have ever had to O. K. a requisition for cleaning slime out of *your* cooling water system . . . or watch costs climb while adherent insulating growths build up in *your* condensors . . . you'll welcome these facts about Santobrite, Monsanto's practical, efficient algaecide.

Santobrite (sodium pentachlorophenate) is highly toxic to algae and other slime-forming organisms, thus keeping cooling water systems free from growth and making for peak efficiency at all times . . . yet it is easy to handle, simple to apply and low in cost.

Write today for Monsanto Technical Bulletin 0-15 which gives complete information on Santobrite—how, when, where and how much to use for best results. MONSANTO CHEMICAL COMPANY, Organic Chemicals Division, St. Louis, U. S. A. District Offices: New York, Chicago, Boston, Detroit, Charlotte, Birmingham, Los Angeles, San Franciso, Montreal.

QUICK FACTS ABOUT
SANTOBRITE

1. Essentially unreactive chemically . . . stable in presence of organic and inorganic substances.

2. In concentrations used for algae control, will not attack metals commonly used in engineering practice.

3. Compatible with other water treatments.

4. Uniformly effective as an algaecide throughout pH range found in cooling practice.

5. Available in one-ounce briquettes, 7 pounds to a cotton bag, 10 bags to a container.

6. Can be applied by simply suspending bag in cooling water.

Detailed information in Technical Bulletin 0-15

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SERVING INDUSTRY . . . WHICH SERVES MANKIND

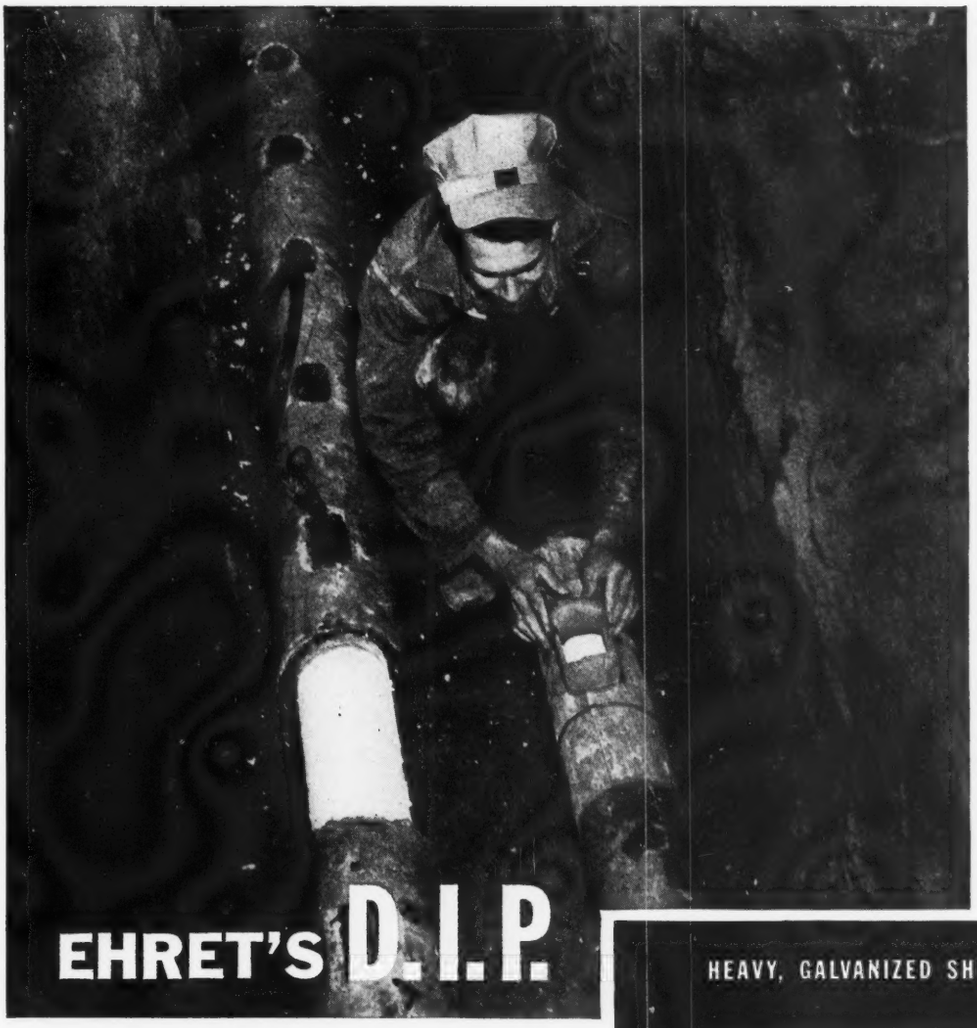
chine operation and shop practice, he turned his attention to the science of governing while still a young man. He demonstrated, before his father and other governor experts, the first mechanically compensated governor, which he designed and built himself. Mr Woodward assumed the presidency of the Woodward Governor Co in 1921, remaining in active charge of all engineering. First application of a hydraulic governor to Diesel engines in 1933 and the development of a successful governor for controlling the pitch of airplane propellers opened two new fields in addition to the established waterwheel governor. For his outstanding work in the engineering field he was made a fellow in the American Society of Mechanical Engineers in 1939 and in 1940 was honored as one of the Modern Pioneers by the National Association of Manufacturers.

IRVING H MORAN, at the time of his death a member of the Mechanical Div, Stone & Webster Engrg Co, passed away in Weymouth, Mass, March 20. He was born in London County, Virginia, in 1886 and received his engineering degree from the University of West Virginia in 1911. He was employed for a number of years by the Potomac Electric Power Co, reaching the position of chief draftsman in 1923, when he was employed by the Stone & Webster Engrg Corp. He had been responsible for the design of many industrial and public utility power plants, including the most recent extension to the South Meadow Station at Hartford, Conn., and the Stamford Power Station of the Conn. Power Co.

PERSONALS

LEE C WILSON, general manager, Reading-Pratt & Cady Div and Reading Steel Casting Div, American Chain & Cable Co, Inc, was awarded the Frederick A Lorenz Medal by the Steel Founders' Society of America at their annual meeting recently. The medal is presented, according to the by-laws of the society, "to the individual adjudged to have made the most outstanding contribution toward the advancement of the steel casting industry during the preceding year."

HENRY LAMY was honored by the Keystone Association No. 16, National Association of Power Engineers, at a meeting held in Buffalo March 13. The occasion marked his 52nd anniversary as a member of the Buffalo unit. A past president of the association, Mr Lamy was chief examiner of stationary engineers for the City of Buffalo from 1906



(*Left*) **Preparing a field joint for permanent asphalt sealing. Narrow trenching is sufficient for installing the D. I. P. system.**

●

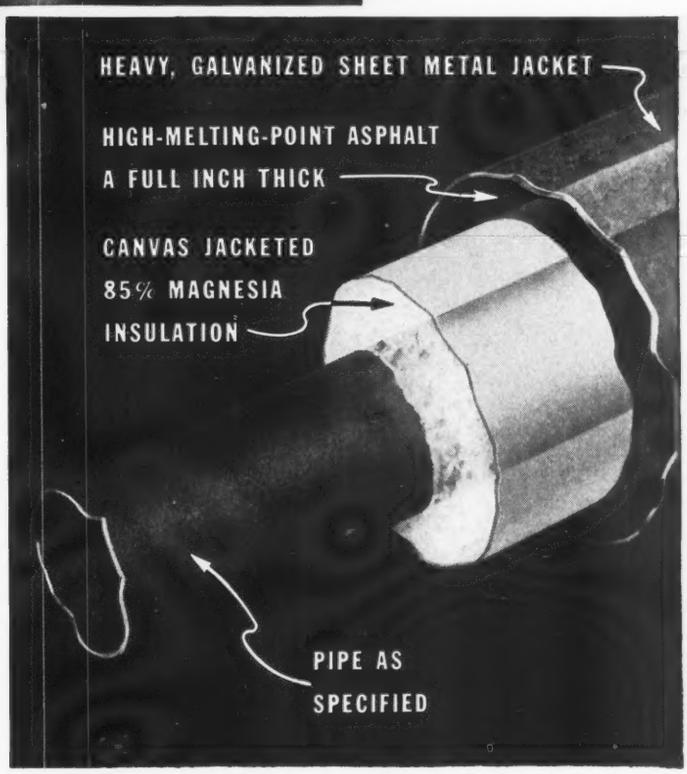
(*Below*) **Sectional view of Durant Insulated Pipe, showing construction features. Pipe, insulation and protection are factory-fabricated into units.**

EHRET'S D. I. P.

SETS STANDARDS FOR UNDERGROUND INSULATED PIPING

Ehret's Durant Insulated Pipe combines the high insulating efficiency of 85% Magnesia and the time-defying characteristics of imperishable asphalt. Added to this advantage is factory-fabricated construction which makes field installation both rapid and economical.

Send for the special Ehret booklet on D. I. P. It contains full details on this modern system for underground insulated piping.



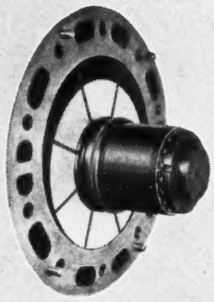
EHRET MAGNESIA MANUFACTURING COMPANY

VALLEY FORGE • PENNSYLVANIA

DISTRIBUTORS IN ALL PRINCIPAL CITIES

FULLER ROTARY COMPRESSORS

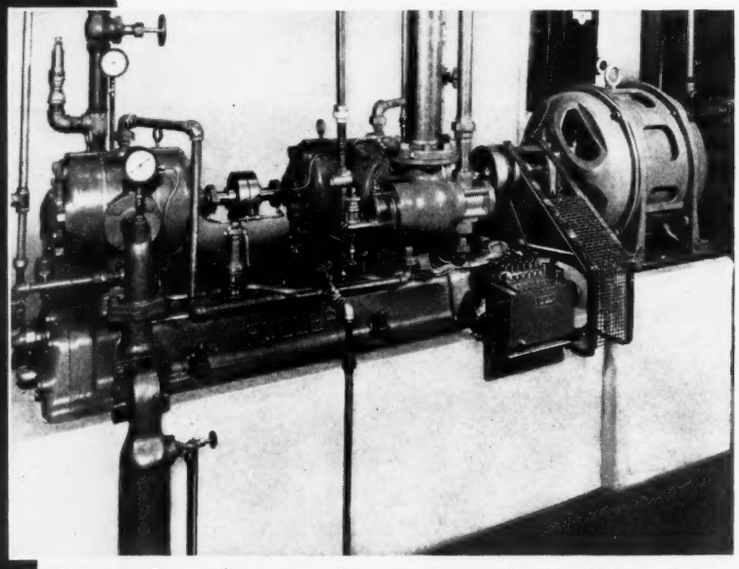
BUILT FOR ANY PRESSURE TO 125-LB.



Hundreds of Fuller Rotary Compressors are in operation, giving owner satisfaction at exceedingly low operating expense. That's what plant superintendents and maintenance men like about them . . . on the job day after day, month in and month out, with practically no attention whatsoever.

It's to your advantage to take time out to become better acquainted with these modern, efficient units for gas or air compression.

Write for Bulletin C3-A



Two-stage Rotary Compressor, base-type intercooler, installed in a large valve manufacturing plant. Capacity 191 C.F.M., 125-lb. pressure.

FULLER COMPANY
CATASAUQUA, PENNSYLVANIA
Chicago: 1118 Marquette Bldg.
San Francisco: 320-321 Chancery Bldg.

C-55

FULLER
PIONEERS OF HIGH-EFFICIENCY ROTARY COMPRESSORS

to 1909. He has been lauded at national conventions of power engineers for distinguished service in the field of refrigerating engineering.

F H Rosencrants, a vice-president of Combustion Engineering Co, Inc, has assumed responsibility for the activities of the company in the marine field, and W A Armacost has been designated as chief engineer of this department. Mr Rosencrants has been with the Texas Power & Light Co, the Electric Bond & Share Co, and the International Combustion Engineering Co, Inc, London, England.

W W Tomes has been appointed head of the Flowmeter Section, Cochrane Corp, and W C Morrison has been named as assistant to Mr Tomes. Mr Tomes was graduated from Purdue University in 1928 and has been associated with Firestone Tire & Rubber Co in flow measurement and steam distribution work. Mr Morrison attended the University of North Carolina and was graduated from the Polytechnic Institute of Brooklyn in 1936. He was lately associated with the Brooklyn Union Gas Co.

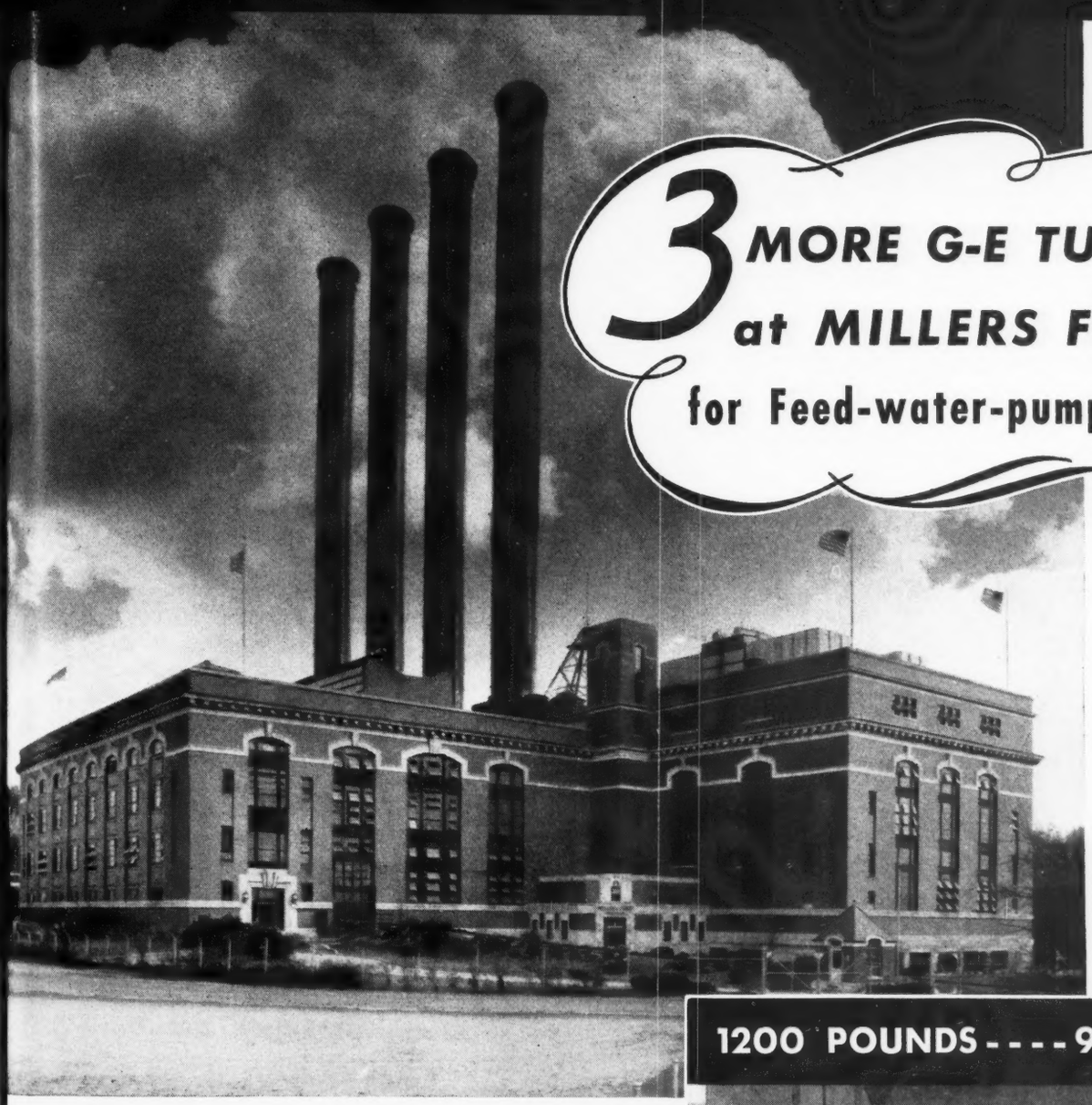
Charles H Hoefer and Harvey T Harrison have been made general superintendent and vice-president in charge of sales, respectively, of the Duraloy Co, Scottdale, Pa. Mr Hoefer was formerly superintendent of the Alloy Div, Lebanon Steel Foundry, Lebanon, Pa., while Mr Harrison has been with the Duraloy Co since 1928.

Andrew Hutton has been appointed works manager of the Passaic, N. J., plant of the Robins Conveying Belt Co. He is in charge of all manufacturing operations, buildings and equipment. Mr Hutton was recently chief engineer of the Davis Engrg Corp, Elizabeth, N. J., and was previously vice-president and general manager of the Taylor Mfg Corp, Milwaukee.

Harry J Scheidt, a graduate of the Polytechnic Institute of Brooklyn, and recently associated with Williamsburgh power plant, has joined the engineering department of Northern Equipment Co. On completing a factory training course, he will be assigned to duty as service engineer.

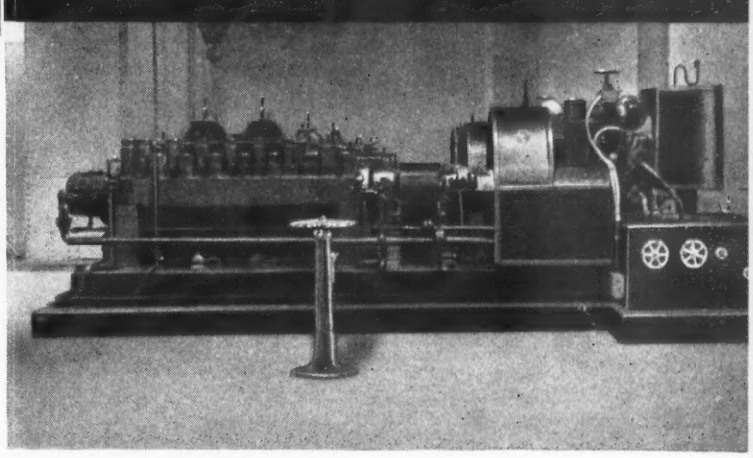
William E Wood was named president of the Virginia Public Service Co recently at the annual meeting of stockholders. Mr Wood, who comes to Virginia Public Service from Stone & Webster Service Corp, New York, succeeds M J O'Connell, who resigned in January of this year. Mr Wood is a

3 MORE G-E TURBINES at MILLERS FORD for Feed-water-pump Drive



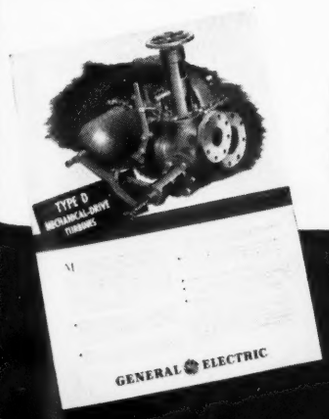
The modern Millers Ford Station of the Dayton Power and Light Company with installed nameplate-rating capacity of 170,000 kw. An additional G-E turbine-generator now on order will bring nameplate-rating capacity to 187,500 kw in 1942.

1200 POUNDS - - - - 900 DEGREES



HIGH availability factor and low maintenance expense—that's why General Electric turbines were selected to drive the three new high-pressure boiler-feed pumps at Millers Ford Station. Dayton Power and Light Company's experience with 1200-lb, 900-deg G-E mechanical-drive turbines dates back to 1937 when two 1002-hp units were put to work. The performance record of these units—operating 18 hours a day, 7 days a week—prompted the selection of "G-E" again to drive the three new boiler-feed pumps. So, today five G-E mechanical-drive turbines are in this station doing double duty—providing highly reliable, low-cost power for pump drive and exhausting clean 215-lb steam for feed-water heating or for generating electric power through low-pressure turbines.

The long-run service satisfaction built into G-E turbines is the result of constant research for better materials and methods, up-to-date manufacturing practice, and testing under operating temperatures and pressures to give advanced proof of performance. Doesn't it stand to reason that you, too, will benefit by taking advantage of G-E experience and using G-E turbines to meet your own needs for dependable power generation? Upon request one of our turbine specialists will give you practical help based on experience with hundreds of installations. General Electric, Schenectady, New York.

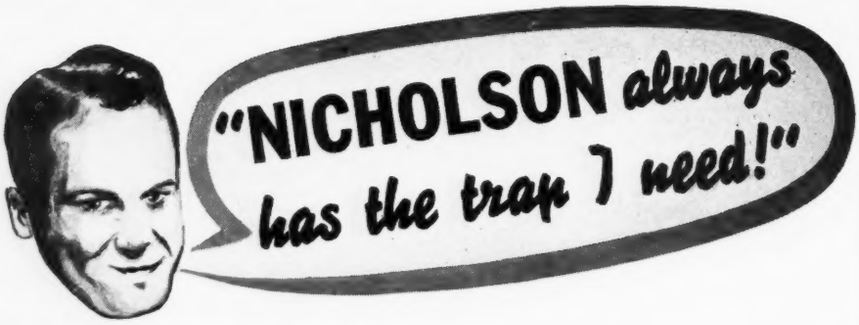


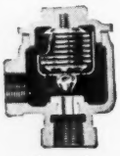
COMPLETE DATA ON THE IMPROVED TYPE D TURBINE

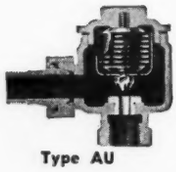
For a quick picture of our improved Type D mechanical-drive turbine—now available with combined trip and throttle valve for *positive overspeed protection* — ask for Bulletin GEA-3557

GENERAL ELECTRIC

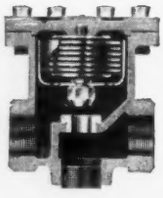
252-4-450



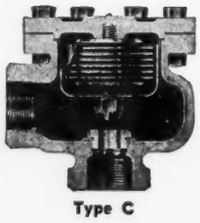

Type A


Type AU

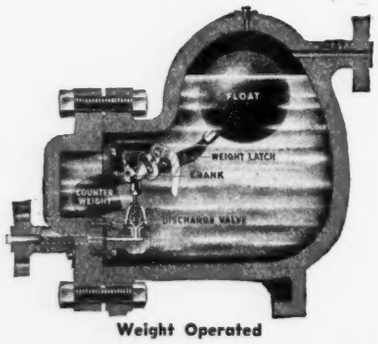
INDUSTRIAL—THERMOSTATIC TYPE


Type B

Two to six times greater valve area and capacity than average traps of corresponding pipe size . . . Discharge air as efficiently as water . . . Will not freeze . . . Require no adjustment from vacuum to maximum pressure . . . Hardened stainless steel valves and seats . . . Seamless bronze bellows for ordinary steam service, with stainless steel bellows available for superheat and corrosive conditions . . . Sizes from ¼" to 2" . . . Pressures from vacuum to 300 lbs.

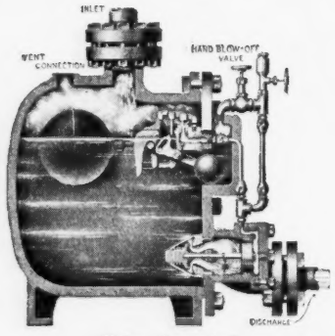

Type C

FOR POWER PLANT APPLICATIONS



Weight Operated

A large capacity, fully automatic, intermittent action trap, built for all pressures from vacuum to 1500 lbs. at 1000 maximum temperature. Suitable for many drainage problems around power plants and on process steam. Will operate under adverse conditions such as dirt, scale, vibration, variations in pressure and superheat.



Piston Operated

A Super-trap with extra large discharge valve operated by a steam piston. Action is positive and instantaneous—no wire-drawing. Float is chrome-nickel steel, chromium-plated and guaranteed not to collapse. Built for pressures from 2 to 650 lbs. at 750° maximum temperature.

Expansion Trap

A continuous-discharge type, operated by the temperature difference between steam and condensate, or varying temperature of condensate alone, as desired. Entirely automatic in action, and easily adjusted for any pressure up to 225 lbs.

WRITE FOR STEAM TRAP CATALOG NO. 240

OTHER PRODUCTS: Control Valves, Steel and Stainless Steel Floats, Air Traps, Air Separators, Flexible Couplings, Expanding Mandrels, Arbor Presses.

W. H. NICHOLSON & COMPANY
125 OREGON ST. WILKES-BARRE, PENNSYLVANIA, U. S. A.

native of Aiken, S. C., and a graduate of Georgia Tech. He came to Virginia from Texas in 1925 as vice-president of the Virginia Electric & Power Co at Richmond. In 1927 he became president of the company and served in that capacity till 1929, when he became associated with Stone & Webster Service Corp.

GORDON E GRAY has joined organization of Ralph M Hill, electrical manufacturers' representative, Chicago, Ill. Mr Gray entered sales engineering work in 1936 when he became associated with the Ohmite Co, where Mr Hill was general sales manager.

Appointment of G A BARKER as manager of Johns-Manville's public utility and electrical products dept was announced April 2. Mr Barker, who has specialized in the development and sales of electrical commodities, was formerly staff manager of the electrical department for Johns-Manville.

BUSINESS ITEMS

NORTHERN EQUIPMENT Co, Erie, Pa., announces appointment of H G Carter, 5505 Branch Ave, Tampa, Fla., as district representative.

WALTER CASTENADO, INC, New Orleans, La., has announced addition of S G Davis to staff. Mr Davis will be engaged in sales engineering work, handling products of Cochrane Corp, Peabody Engrg Corp, Schutte & Koerting Co, DeLaval Separator Co, Ames Iron Works, the Hays Corp, Zallea Bros & Johnson, Schubert-Christy Corp, DeLaval Steam Turbine Co, Binks Mfg Co, Northern Equipment Co, United Conveyor Corp, Yeomans Bros Co, and American Arch Co.

GROVE REGULATOR Co has recently moved into its new offices and plant located at 1190-67th St, Oakland, Calif. New factory includes complete testing laboratory, manned by staff of chemical and metallurgical engineers. New 10,000 lb hydraulic testing unit and an automatically controlled testing boiler is part of installed equipment.

FOOTE BROS GEAR & MACHINE CORP, Chicago, Ill., has appointed Joseph S Potts, Jr, as representative in Virginia, for line of company products.

BLACKMER PUMP Co announces several changes in personnel. W E Burke of Boston, Mass., has been appointed New England representative of the company; H D McClintock of Erie, Pa., becomes Blackmer representative in eleven counties of northwest Pennsylvania territory; and W R Barrington

THEY LAUGHED WHEN WE SAID,

"We'll run it with air!"

"YOU'RE tilting at windmills. It just won't work." That's what the scoffers said when Hagan engineers pioneered automatic combustion control with air for power. "You just can't run a control system on wind."

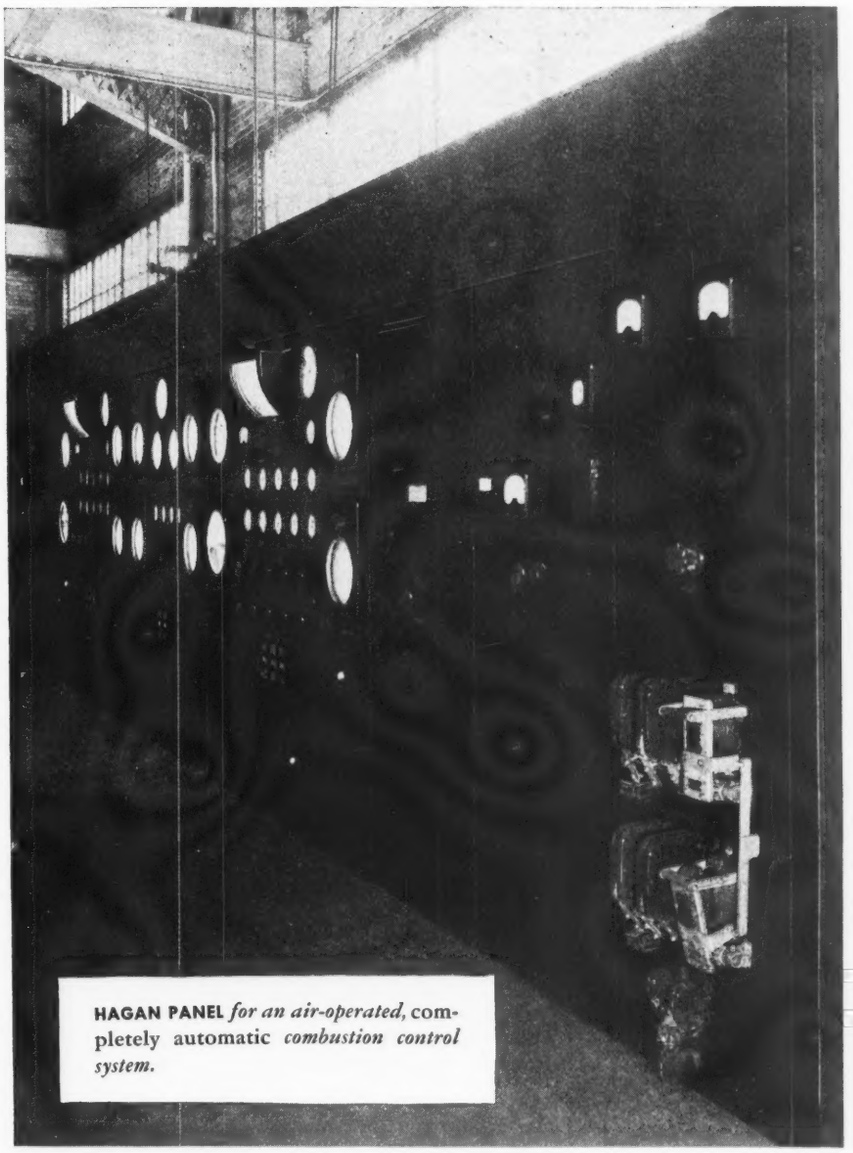
Now, however, the soundness of the Hagan-engineered control principle has clearly been proved—air operation is standard practice today.

Air-operated Hagan Automatic Combustion Control is fast and positive, reliable in service, and makes adjustments accurately, in proportion to the rate and extent required. It maintains close control of steam pressure, air flow, fuel supply and furnace draft. This results in higher over-all plant efficiency and lower fuel costs.

When you buy *automatic* control, make sure it is *really* automatic, that the push-buttons and hand-wheels provided are to be used for occasional adjustments only, *not for continuous manual control.* Hagan installations are truly automatic—in name *and* operation.

Even with inexperienced operators, plants can produce maximum steam output because the *control* does the thinking. It maintains highest efficiency and makes plants virtually self-operating. Nowhere has this been more conclusively proved than in England, during air raids. Hagan-controlled plants *carry on alone.*

Let us show you the way to lower power costs.



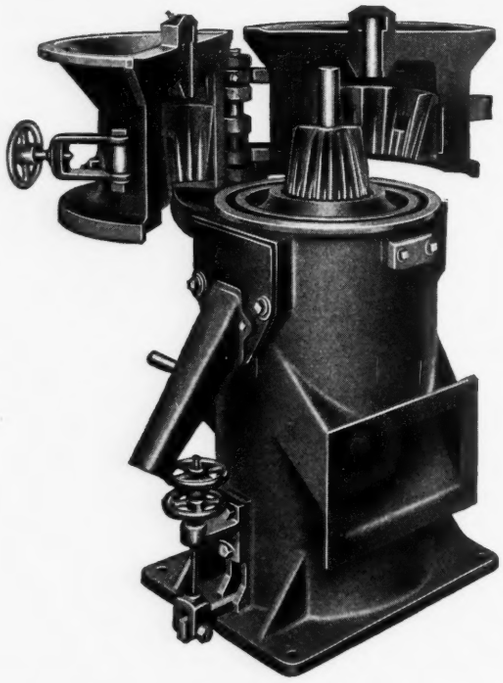
HAGAN PANEL *for an air-operated,* completely automatic *combustion control system.*

HAGAN CORPORATION · 300 ROSS STREET · PITTSBURGH, PA.

HAGAN *Automatic* COMBUSTION CONTROL

The pioneer . . . and still the leader

COAL ANALYSIS SIMPLIFIED with "THE IMPROVED STURTEVANT *AUTOMATIC* COAL CRUSHER AND SAMPLER"



Get full value from your coal . . .

Many plants are now operating at 24-hour capacities thereby using three times more coal than for normal operation. In operating normally, analysis of coal may seem unimportant but consider the loss if you are not getting the true value in your coal purchases, when consuming these additional quantities.

Eliminates 32 hand operations . . .

The Sturtevant Automatic Coal Crusher and Sampler eliminates 32 of the 34 tedious and inaccurate hand operations necessary for the sampling of coal. Every sample taken from this unit is true and representative of all the material passed through it and to a fineness of practically all minus 8 mesh screen size.

WRITE TODAY for Bulletin 85 giving further information.

Sturtevant Mill Co.

103 Clayton St. Dorchester, Boston, Mass.

has been named representative in the Cleveland, Ohio, territory.

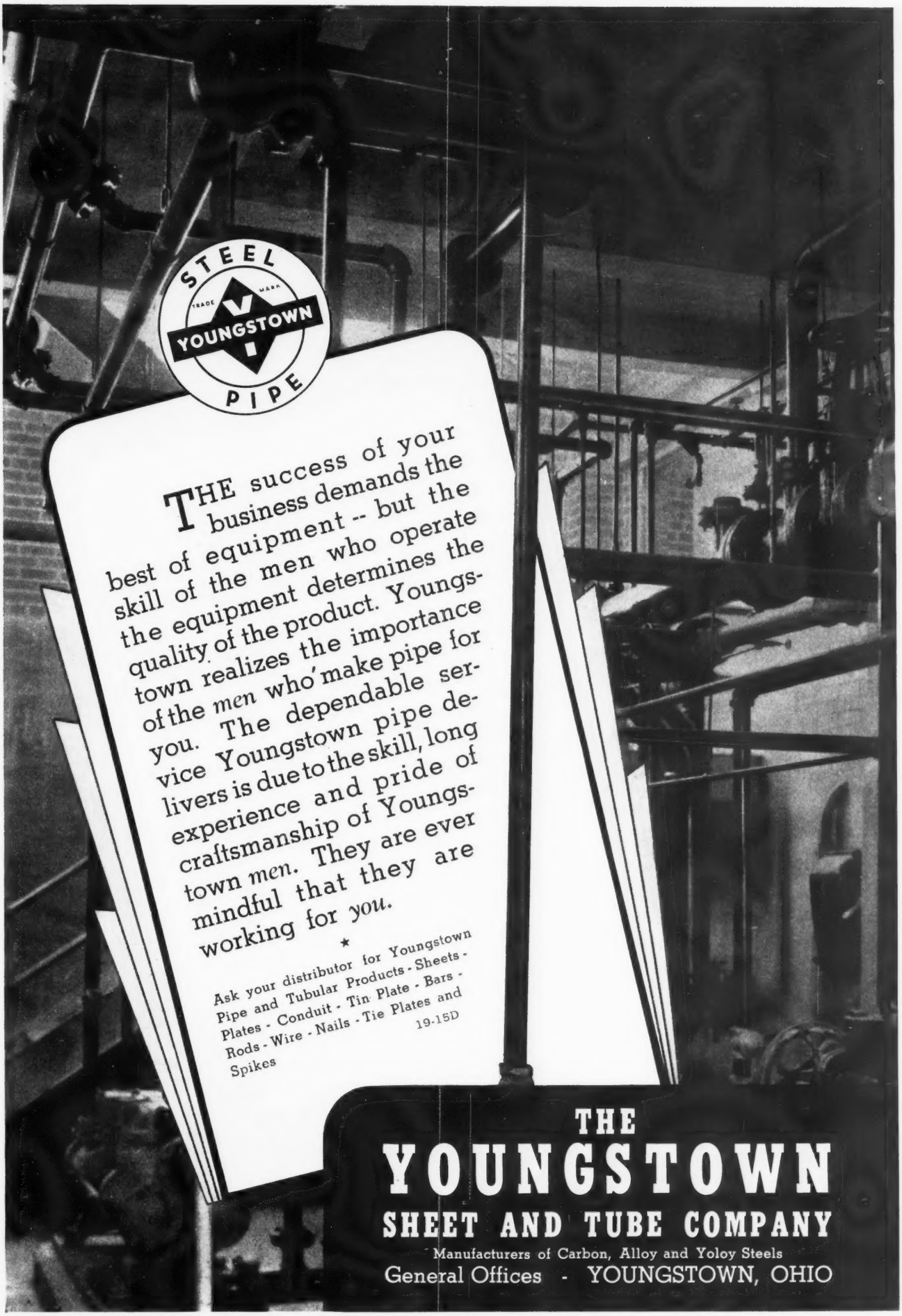
Chicago district activities of GENERAL ELECTRIC Co, formerly scattered in nine different locations, are now housed in G E's new $1,500,000 building at 840 South Canal St, in Chicago. Occupying entire city block, structure is seven stories high. It was designed by architects Holabird & Root, and erected by James Stewart Corp, general contractors. Directed from new regional headquarters building are General Electric's sales, engineering and servicing operations in 11 midwestern states and parts of three others, including offices at Davenport, Detroit, Kansas City, Milwaukee, Minneapolis, Omaha and St. Louis.

ALLIS-CHALMERS MFG Co, Milwaukee, Wis, announces several personnel changes: James M White has been appointed assistant general works manager. He was formerly with the company's LaPorte works, a post he held for the past 6 years. Lee H Hill, widely known transformer engineer, has been named assistant manager of the company's Electrical Dept. Mr Hill has been head of the company's Transformer Dept since 1936. Carlton B Smith, formerly district service manager in the Southeast district, has been promoted to district superintendent of service and erection, with headquarters in the Healey Bldg, Atlanta, Ga.

LAMINATED SHIM Co, Glenbrook, Conn., announces new appointments of executives. E B Nisbet, formerly purchasing agent and treasurer, becomes executive vice-president; E R Young, formerly factory manager, has been made vice-president in charge of production; and Richard Seipt, present sales manager, takes on additional duties as vice-president in charge of sales.

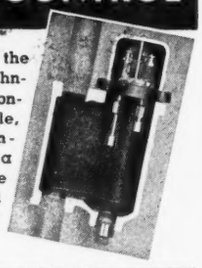
Beginning March 17, 1941, New York office of MERCOID CORP is located at Room 1307, Equitable Life Building, 393 Seventh Ave, N. Y. R F FISHER is vice-president in charge of the office.

KAYE & MCDONALD, West Orange, N. J., announces following new representatives of K-Master line: Gerry H Wieland, 6740 E 13th St, Indianapolis, Ind.; Wm K Clow, Jr, 610 W Michigan St, Milwaukee, Wis.; Richard Equipment Co, 2137 Reading Rd, Cincinnati, Ohio; Ernest E Lee Co, 343 S Dearborn St, Chicago, Ill.; Norman W Calvert Co, Auditorium Bldg, Cleveland, Ohio; Dale Prentice, 424 Book Bldg, Detroit, Mich.; Bower Supply Co, 1902 S Harrison St, Fort Wayne, Ind.;


STEEL
TRADE
YOUNGSTOWN
MARK
PIPE
THE success of your business demands the best of equipment -- but the skill of the men who operate the equipment determines the quality of the product. Youngstown realizes the importance of the men who make pipe for you. The dependable service Youngstown pipe deliverers is due to the skill, long experience and pride of craftsmanship of Youngstown men. They are ever mindful that they are working for you.
★
Ask your distributor for Youngstown Pipe and Tubular Products - Sheets - Plates - Conduit - Tin Plate - Bars - Rods - Wire - Nails - Tie Plates and Spikes
19-15D
THE
YOUNGSTOWN
SHEET AND TUBE COMPANY
Manufacturers of Carbon, Alloy and Yoloy Steels
General Offices - YOUNGSTOWN, OHIO

GOOD NEWS

For every plant operator who wants AUTOMATIC BOILER WATER CONTROL

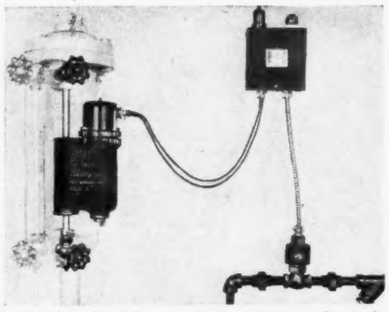


● Interior view of the electrode holder, Johnson Boiler Water Control. Note the simple, uncomplicated construction. If desired, a third electrode can be furnished to sound low water alarm or cut-off burner

IF you've thought that dependable, automatic control of the boiler water level was an expensive proposition, you have a welcome surprise coming. Hundreds of Johnson Boiler Water Controls are proving that they offer the same safety and convenience as the most elaborate systems—at a price that even the smallest plant can afford.

NEW ELECTRICAL OPERATION

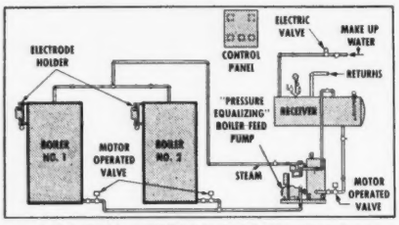
The low cost of the Johnson Boiler Water Control is made possible by its new electrical method of operation, which does away with all complications. Two trouble-free metal electrodes are placed at the boiler water line, so that the water itself, as it rises and falls, makes and breaks a circuit to an electric relay. This relay in turn opens a valve to admit make-up water, or starts the boiler feed pump.



● Model A, Johnson Boiler Water Control, used to control electric valve admitting make-up water. Electrode holder is shown mounted on water column. Relay at top opens electric valve in water supply line.

DEPENDABLE, EASY TO INSTALL

Besides being considerably less expensive, this simpler construction makes the Johnson Boiler Water Control thoroughly dependable, and far easier to install. There are no moving parts of any sort which can jam or clog or become inoperative from scale accumulation. Operation is as dependable as the flow of electricity. Any plant operator can quickly hook it up right on the water column, or connect it to other suitable openings in the boiler. No water piping is necessary.



JOHNSON MULTIPLE BOILER CONTROL

● Enables one boiler feed pump to handle two or three boilers. Each boiler is watched individually—water maintained always at a safe level. (Electrical wiring not shown.)

FOR ALL SERVICES

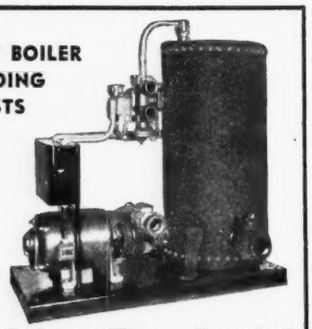
The Johnson Boiler Water Control is suitable for pressures up to 300 lbs. It can be used to admit make-up water, to control electric or steam pumps, to sound low water alarm, to cut off burner at dangerous water level, or for any combination of these duties. Newest development is the Johnson Multiple Boiler Control diagrammed at right. It maintains the proper water levels in two or three boilers, according to individual requirements, using just one boiler feed pump.

WRITE FOR NEW BULLETIN

The Johnson Corporation

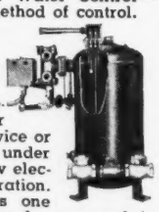
865 WOOD STREET, THREE RIVERS, MICH.

CUT BOILER FEEDING COSTS



—with the Johnson "Pressure Equalizing" Boiler Feed Pump. Revolutionary operating principle saves remarkably on cost of pumping, increases thermal efficiency, cuts maintenance. A perfect team-mate for the Johnson Boiler Water Control—uses same electrical method of control.

USE THE JOHNSON ELECTRAP



● Today's highest development in a trap for pumping or lifting service or for draining systems under high vacuum. Uses new electrical method of operation. Control valve gear is one compact assembly—can be mounted in any convenient location if trap chamber must be set in inaccessible position.

and E A Rogers, Chattanooga Bank Bldg, Chattanooga, Tenn.

WHITING CORP, Harvey, Ill., announces that S H Hammond, until recently manager of Appliance Div, is now in charge of all Whiting branch

S H Hammond

offices, as director of the field force. M F Becker, formerly field-force director, has been promoted to co-manager of Equipment Div.

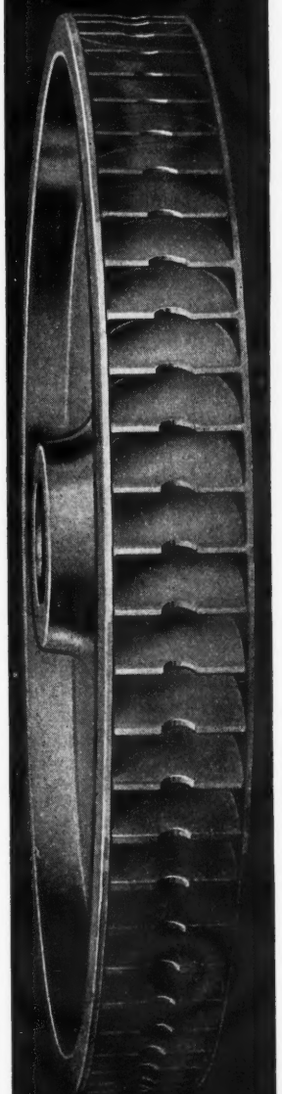
UNIVERSAL GEAR CORP, Indianapolis, Ind., announces appointment of J F Johnson and associates, as district representative for Western New York, including the Buffalo and Syracuse Areas, and full charge of the company's activities in that locality. Offices are at 707 Dun Bldg, 110 Pearl St, Buffalo, N. Y.

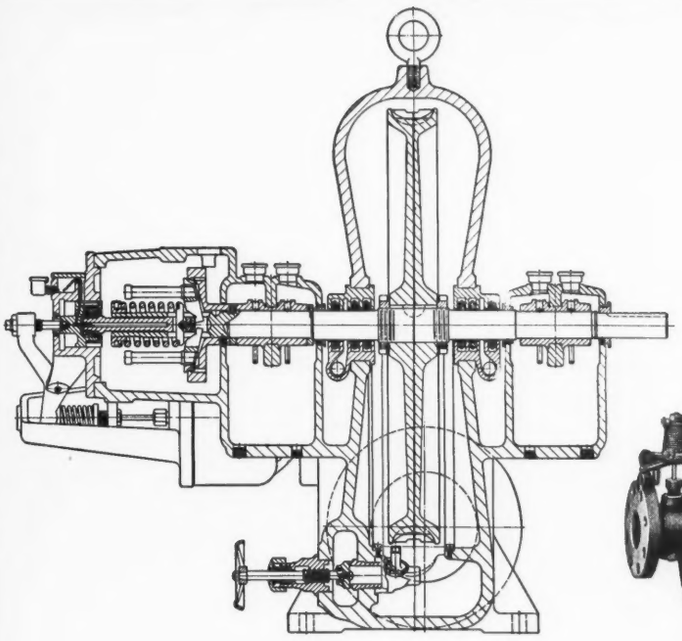
Board of directors of AMERICAN BRASS CO announces election of following officers and directors to fill existing vacancies: John A Coe, chairman of the board; Clark S Judd, president; Arthur H Quigley, executive vice-president; Edwin J Rockwell, secretary and treasurer; W Kenneth Daly, comptroller; Charles E Steele, assistant secretary; and Mr Coe and Mr Quigley, directors.

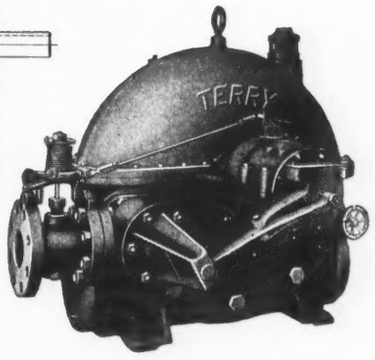
HAGAN CORP, BUROMIN CO, and CALGON, INC, Pittsburgh, Pa., announce opening of branch office in Detroit at 2512 Book Bldg. Arthur R Borden will be in charge of activities of Hagan, Hall Service and Buromin, while Robert Graf will handle Calgon business. They will be assisted by W H Weitzel.

STEEL PRODUCTS SALES CORP, 52 Vanderbilt Ave, New York, N. Y., have

TERRY







For Year After Year Service — The Terry Solid Wheel Turbine

The Terry Solid Wheel Turbine employs a one piece steel wheel. The buckets are milled from the solid metal. There are no parts to become loose or to work out.

The blades have large clearances and are double rim protected. End play cannot damage the blading and it is impossible for it to foul.

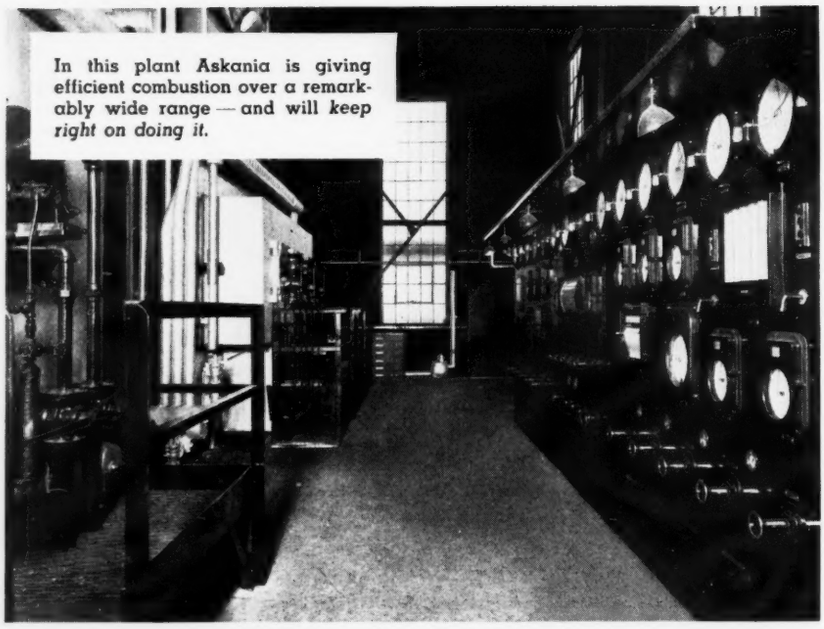
The power producing action of the steam in the wheel takes place on the curved surfaces at the back of the buckets and therefore close blade clearance is not necessary.

Terry Solid Wheel Turbines are available in ratings from 5 HP to 2000 HP and are built for all commercial steam pressure and exhaust pressures. They are described in our bulletin S-116. A request on your business letterhead will bring a copy.

Above: Cross section of typical Terry Solid Wheel Turbine.

T-1141

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.



The advertisement a user wrote-

A MAN who knows his power plant equipment told our story better than we can tell it. Said he:

"When I decided to pick a combustion control, I realized there were a number of them that would do a satisfactory job at the start — but I wanted to be sure we installed the kind that would stand up and do a job year after year.

"In your jet pipe you had the simplest, most accurate way I had ever seen to control anything that needed controlling. All other devices that laid claim to the same accuracy were mighty complicated, and it was easy to see that the same number of dollars buy a lot more quality in a simple machine than they can buy in a complicated machine.

"On top of that I liked the idea of using oil as an operating medium so that all parts ran in oil and there was plenty of power to operate the valves and dampers. Now I know I was right. The system *is* right and *stays* right year after year without attention or maintenance. It's the familiar story of the best being the cheapest in the long run."

We can only add that the jet pipe principle is an *exclusive* Askania principle. Ask for interesting bulletin explaining it in detail.

ASKANIA REGULATOR COMPANY
Corner 16th and Michigan, Chicago, Illinois

ASKANIA
Combustion
CONTROL

been appointed New York representatives of Downingtown Mfg Co, Foundry Div, Downingtown, Pa.

CHICAGO PNEUMATIC TOOL CO, New York, announces appointment of Frank B Ridley as manager of San Francisco office. Mr Ridley succeeds H P Hansen, who continues with the company in a sales capacity.

Work has begun on construction of $500,000 addition to STERLING ENGINE Co plant at 1270 Niagara St, Buffalo, N. Y., according to announcement made recently. New building, providing about 75,000 sq ft of space, will be ready by September of this year and will be used for assembling and testing Sterling Admiral engines. Robert E Williams & Sons Co, Inc, of Buffalo, are general contractors.

Chief Engineers Study Combustion

With the cooperation of the Hays Institute of Combustion, the Chief Engineers Association of Chicago has organized a combustion class for its members, using the Institute's textbooks and instructors. Announcing this class, the Chief Engineers Association stresses the increasing importance of good combustion and correct furnace operation.

MEETINGS

American Association for the Advancement of Science—*108th Meeting, June 23–28, Durham, N. H.*

American Institute of Electrical Engineers—*Summer Convention, June 16–20, 1941, Toronto, Ontario, Canada. H H Henline, national secretary, 33 W 39 St, New York, N. Y.*

American Society of Mechanical Engineers—*Semi-Annual meeting, June 16–20, 1941. Hotel Muehlbach, Kansas City, Mo. Oil and Gas Power Div, Meeting June 11–14, Kansas City, Mo. C E Davies, secretary, 29 W 39th St, New York, N. Y.*

American Society of Heating and Ventilating Engineers—*Semi-annual meeting and Pacific Coast Heating and Air Conditioning Show, June 16–20, 1941. Palace Hotel, San Francisco, Calif.*

American Society for Refrigerating Engineers—*28th Spring Meeting, May 27–29, 1941. Hotel Gibson, Cincinnati, Ohio.*

Eastern Photoelasticity Conference—*13th Semi-annual meeting, June 12, 13, 14, 1941. Cambridge, Mass. W M Murray, chairman, Rm 1–321, Massachusetts Institute of Technology, Cambridge, Mass.*

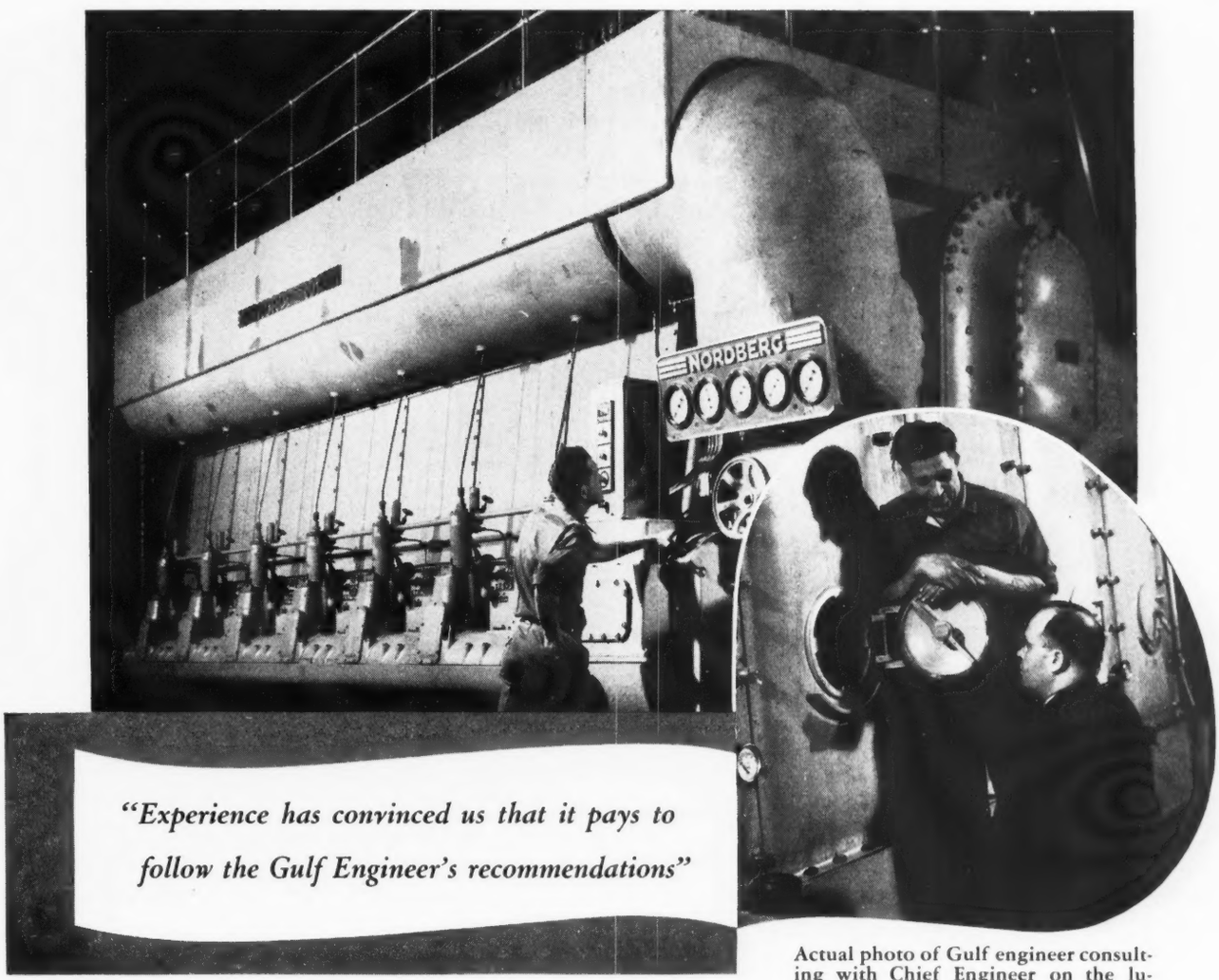
National District Heating Association—*Annual Meeting, June 10 to 13, 1941. William Penn Hotel, Pittsburgh, Pa. John F Collings, Jr, secretary-treasurer, 1231 Grant Bldg, Pittsburgh, Pa.*

Smoke Prevention Association—*35th Annual Convention, June 3–6, Hotel Ansley, Atlanta, Ga., Assn headquarters, 139 N Clark St, Chicago, Ill.*

Society for the Promotion of Engineering Education—*49th Annual meeting, University of Michigan, Ann Arbor, Mich. June 23–27, 1941.*

"Our units operate MORE EFFICIENTLY with GULF DIESEL OILS"

—Says this Chief Engineer



Actual photo of Gulf engineer consulting with Chief Engineer on the lubrication of this new 3,000 h.p. Diesel.

"GULF Diesel Oils help us keep both our older Diesels and this new unit operating at peak efficiency," says this chief engineer. "We've proved that it pays to use the highest quality Diesel lubricating oils obtainable—those recommended by the Gulf engineer."

Operators everywhere report increased efficiency of their Diesel equipment after Gulf's quality lubricants have been placed in service. They find that these oils retain their high lubricating value for longer periods of time under all operating conditions — that they insure minimum wear of moving parts, full compression and full power.

If you are seeking improved performance and lower maintenance costs from your Diesels, take advantage of Gulf Periodic Consultation Service. Call in the Gulf engineer in your vicinity and ask him to recommend the best lubrication practice. He can give you expert money-saving advice.

The Gulf line of more than 400 quality oils and greases are quickly available to you through more than 1200 Gulf warehouses located in 30 states from Maine to New Mexico. Write or 'phone your nearest Gulf office today.

GULF INDUSTRIAL LUBRICATION

GULF OIL CORPORATION · GULF REFINING COMPANY · PITTSBURGH, PA.

"You can bank on FAIRBANKS"

Don't Let Valve Failure Delay Defense Work

With National Defense requirements calling for the utmost speed, this is no time to risk shut-downs and delays due to valve troubles. Whether your plant is working directly or indirectly on defense work, production MUST continue "full speed ahead."

Interruptions from valve failure can positively be eliminated by using Fairbanks renewable Valves. For if a leak develops after long usage, you simply remove the worn seat ring or disc and slip in a new one while the valve is in the line. This takes only a *few minutes* and costs but a few cents.

Fairbanks Valves represent the highest in material and workmanship, in types to properly fill particular needs.

Why not check up on your valve requirements today and get in touch with your Fairbanks' distributor. Write us for Catalog No. 21.

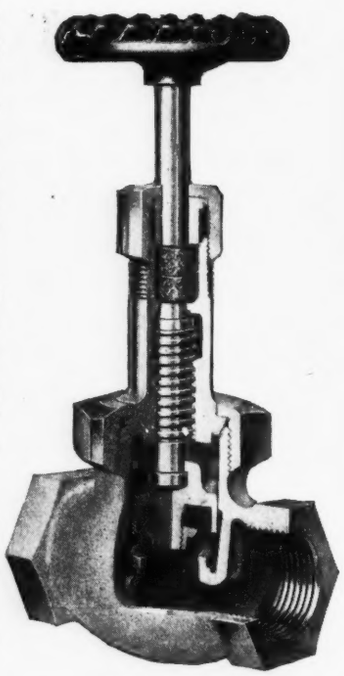


Fig. U-01
150 lbs. Steam Pressure

THE FAIRBANKS COMPANY
Valves, Dart Unions, Hand Trucks and Wheelbarrows
397 LAFAYETTE ST. NEW YORK, N. Y.

Boston, Mass., Pittsburgh, Pa., Distributors in Principal Cities. Factories: Binghamton, N. Y., Rome, Ga.

Fairbanks *Standard and* Renewable Valves

Walker Becomes Vice-President, Ebdon General Sales Manager of Combustion Engineering Co

Donald S Walker, for several years general sales manager of Combustion Engineering Company, Inc, was named vice-president in charge of sales at a meeting of the Board of Directors on April 11. Mr Walker is a graduate

Donald S Walker

of the U. S. Naval Academy, Class of 1924, and for the next 10 years was associated with D H Skeen & Co of Chicago, in charge of Ljungstrom Air Preheater sales, becoming vice-president of that company and subsequently president of its subsidiary, the Mercon Regulator Company.

Mr Walker joined Combustion Engineering Company in December, 1934, as manager of the Philadelphia district. Among the engineering societies of which he is a member are the American Society of Mechanical Engineers, the Society of Naval Architects & Marine Engineers, the Iron & Steel Institute and the Army Ordnance Association; also the Engineers Club of New York.

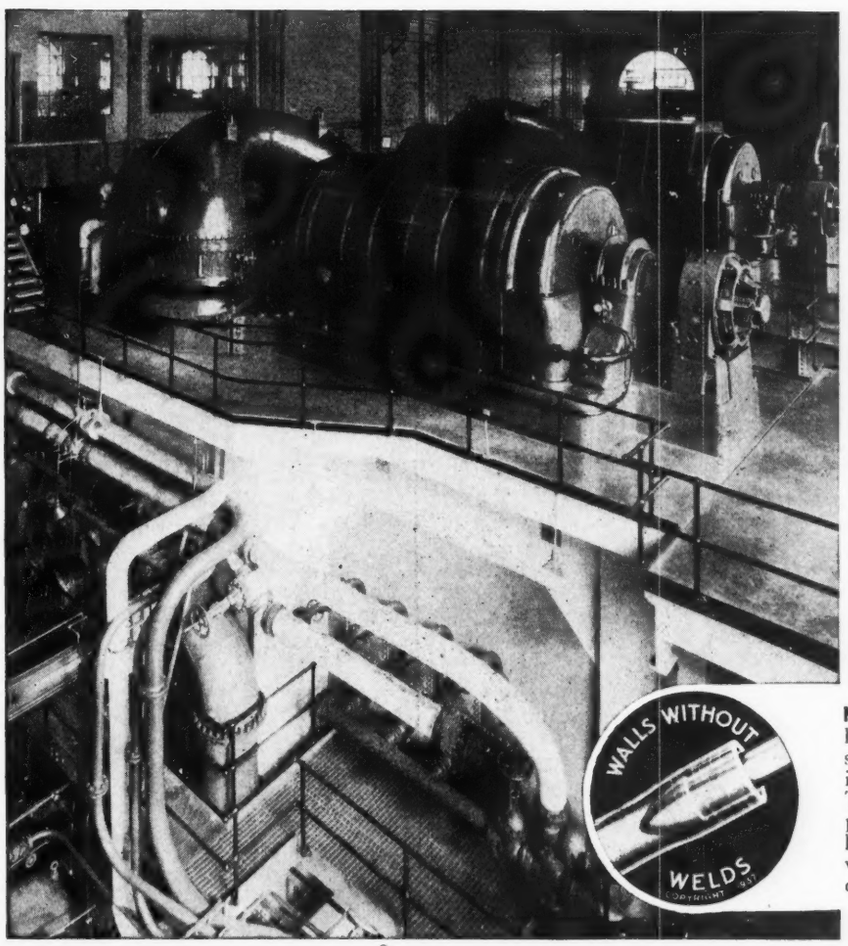
H G Ebdon, formerly assistant general sales manager, has been advanced to general sales manager to succeed Mr Walker. Receiving his technical education at Cooper Union and Brooklyn Polytechnic Institute, followed by several years with the Consolidated Gas Co and the Wilputte Coke Oven Co, Mr Ebdon joined Combustion Engineering Company in 1917, and has served in various capacities in the engineering, test and sales divisions. He is a member of the ASME and the Engineers Club of New York.

Take no chances

with your high pressure lines

"The safest pipe is NATIONAL SEAMLESS"

say leading power engineers



BEHIND this nation-wide preference of those who "know" is an abundance of proof! Countless installations—many under the most severe conditions — are convincingly demonstrating the outstanding ability of NATIONAL Seamless. Wherever pipe is mentioned for handling high pressure steam, power plant experts agree, "You're safest with NATIONAL Seamless!"

NATIONAL Seamless gets its reputation for fine service from handling many tough jobs, and handling them well. That's why in these days of mounting pressures and rising temperatures it is the standby of practical power engineers. It's considered "tops" in power plant piping—the finest modern pipe manufacturing methods can produce. Write today for detailed information.

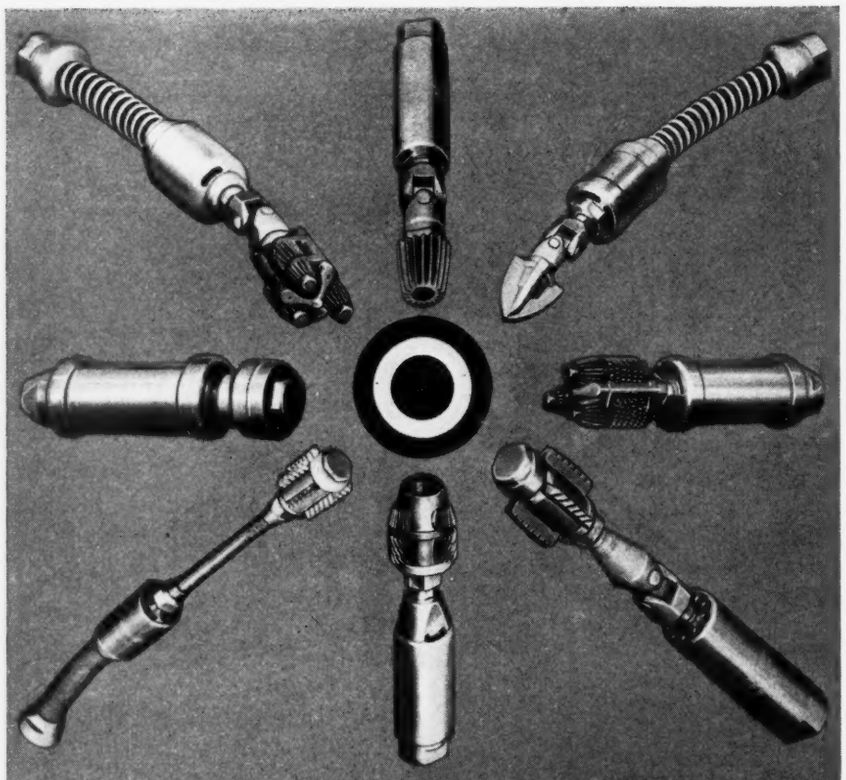
National Seamless means—pierced from solid billets of fine quality steel. Only sound and flawless steel can be pierced successfully, since any existing defects cannot be covered up in the process. Thorough inspection and tests at every stage in production give you double assurance that each length of NATIONAL Seamless will display uniform wall strength, uniform physical properties, and dimensional accuracy.

NATIONAL TUBE COMPANY

PITTSBURGH, PA.

Columbia Steel Company, San Francisco, *Pacific Coast Distributors* • United States Steel Export Company, New York

UNITED STATES STEEL



TO BE *SURE* OF CLEAN TUBES—
BE *SURE* TO USE WILSON CLEANERS

If you buy Wilson Tube Cleaners you can be *sure* that you have the most *efficient* and *economical* tube cleaners obtainable. Wilson Tube Cleaners have the *extra* power, *extra* speed and *extra* strength which assure *quicker, better* and *safer* tube cleaning.

There is a Wilson Tube Cleaner, cutter head, brush or other accessory especially designed and built for rapidly, efficiently and economically cleaning *any* ferrous or non-ferrous metal tube or pipe—straight or curved—of large or small diameter—that can be cleaned mechanically.

Write for the name of our representative nearest to you or send for a copy of our thirty-six page catalog fully describing and illustrating the complete line of Wilson tube cleaning equipment.

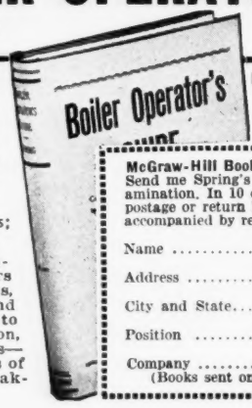
THOMAS C. WILSON, Inc.
PIPE AND TUBE CLEANERS EXCLUSIVELY
47-28 37th Street Long Island City, N. Y.

THIS NEW BOILER OPERATOR'S GUIDE
. . . can mean money to you!

JUST OUT! Here's information of the most priceless sort for you — whether you want to improve your ability as an inspector or to utilize effective inspection methods in the more efficient, safer operation and upkeep of your own boilers.

Helps you meet everyday problems; Prepares you for license exams

With hundreds of typical examination questions and answers as well as complete instructions, this book presents fully and plainly the things you want to know about proper installation, operation, and care of boilers—the things that prevent dollars of loss in reduced efficiency, breakdown, or even accident.



By H. M. Spring, Jr.
353 pages, 6 x 9
241 illustrations
$3.00

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Send me Spring's Boiler Operator's Guide for 10 days' examination. In 10 days I will send you $3.00, plus few cents postage or return book postpaid. (We pay postage on orders accompanied by remittance.)

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Diesel Men to Meet in Kansas City, Mo.

A novel "diesel quiz", in which engineers and operators will try to stump the "experts", will highlight the program of the 14th National Meeting and Exhibit, Oil and Gas Power Division, ASME, to be held June 11–14 at the Hotel President, Kansas City, Mo.

The five technical sessions are tentatively scheduled as follows:

Wednesday PM, June 11—New Developments: "The Chrome Hardening of Cylinder Bores", by H van der Horst; "Application of Compression-Ignition Oil Engines to Aviation", V L Maleev.

Thursday AM, June 12—"Power Plants": "Design of Diesel-Engine Foundation", by Kenneth Larkin; "Instruments and Automatic Control Apparatus for Diesel Operation", by W H Sission; "Centrifuging of Fuel and Lubricating Oil", by C W Bryden.

Thursday PM, June 12—Inspection and Maintenance: "Inspection Instruments and Procedures for Diesel Engines", by Ervin R Spencer; "Diesel-Engine Casualty Experience", by H V Vander Eb.

Thursday Evening, June 12—Diesel Quiz: C G C Rosen, chairman.

Friday AM, June 13—Research: "Hydraulic Characteristics of Fuel-Injection Nozzles", by O F Zahn, Jr.; "Release-Pressure Measurements for Indicating Diesel-Engine Performance", by B H Jennings and T E Jackson.

Saturday AM, June 14—Supercharging: "Results from Operating Supercharged Engines in Pipeline Pumping Service", by J B Harschman and W G Heltzel; "Test Results with Under-Piston Supercharging", by E S Dennison.

GE Defense Orders on Schedule

Production of turbines, vital to defense for propulsion of merchant and naval vessels as well as for generation of electric power on land, is ahead of schedule at General Electric, it was disclosed by Charles S Wilson, president, at the recent annual stockholders' meeting in Schenectady.

Mr Wilson also said that the company is up to schedule on a large share of its other production. General Electric had, as of April 15, $500,000,000 worth of orders on hand, three-quarters of which are for national defense.

General Electric now has slightly over 105,000 employees on its payroll, and more are being added at the rate of 1000 per week. There are more employees on the rolls now than at any time in the company's history.

MORE POWER TO WASHINGTON

Carey HEAT INSULATIONS REPEAT

ON BUZZARD POINT POWER PLANT EXTENSION

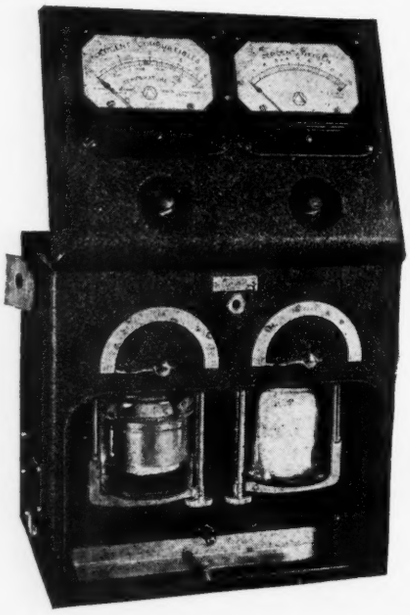
THE capacity of Buzzard Point Station of the Potomac Electric Power Company last year was increased by the addition of a 50,000-kw turbine-generator and a 525,000-lb. per hour boiler—an extension made necessary by the normal load growth of the Washington area and the requirements of the defense program.

Naturally, for an improvement of this type, insulations of outstanding performance were required. In this case, however, a *choice of insulations* was not difficult. For when the first turbine and two boiler units of Buzzard Point were built some years ago, the piping, breeching and accessory apparatus were insulated with CAREY Products. The performance of these insulations, both as to efficiency and permanence, was a matter of record *right in the plant.*

CAREY Insulations always are top-ranking repeaters wherever top efficiency is a requirement. Over fifty years of research, manufacturing experience and success are back of them. You're always SAFE with CAREY Insulations. Write for Insulation Catalog—address Dept. 16.

THE PHILIP CAREY COMPANY • Lockland, Cincinnati, Ohio
Dependable Products Since 1873
IN CANADA: THE PHILIP CAREY COMPANY, LTD. Office and Factory: LENNOXVILLE, P. Q.

Users of CITIES SERVICE LUBRICANTS



get an EXTRA ADVANTAGE with HEAT-PROVER SERVICE

Heat-Prover Service is now available to users of Cities Service Industrial Fuels and Lubricants. This is an economy measuring service which you can secure in addition to the quality and economy advantages offered by Cities Service's SERVICE PROVED Fuel and Diesel Oils.

The Heat-Prover is an ingenious device — a by-product of our research in metallurgy. It registers continuously and instantaneously changes in the amount of oxygen and combustibles in furnace gases. It is an excellent guide in adjusting 4-cycle Diesels and for combustion control in heat generating plants. In the heat treatment of metals, it is invaluable. It assures uniformity and reduces scrap losses.

Let us tell you how you can secure the use of one of these machines. Mail the coupon today for further information.

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***FREE*—Just clip and mail**

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Please tell me how I can get Heat-Prover Service in my shop. PR.

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Reader's Problems

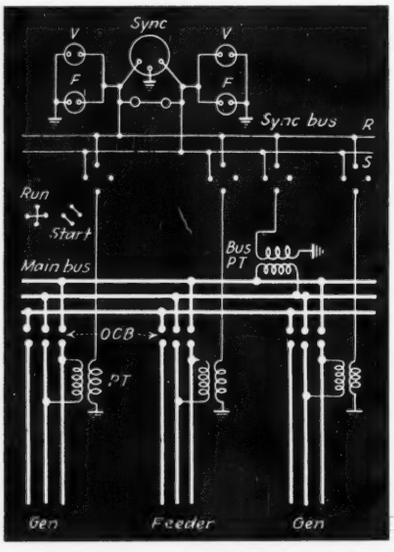
(Continued from page 107)

them, as is done with the kilowatt load; but with generators of identical design a reactive meter on each machine is not absolutely necessary, as this requirement can be met by keeping the same value of field current on each generator.

The incoming feeder should have kilowatt-hour, and reactive kilovolt-ampere-hour meters to register the incoming as well as any outgoing load. Proper relays should be installed for tripping the feeder oil circuit breaker for overload or other protection which is deemed necessary for this particular installation.

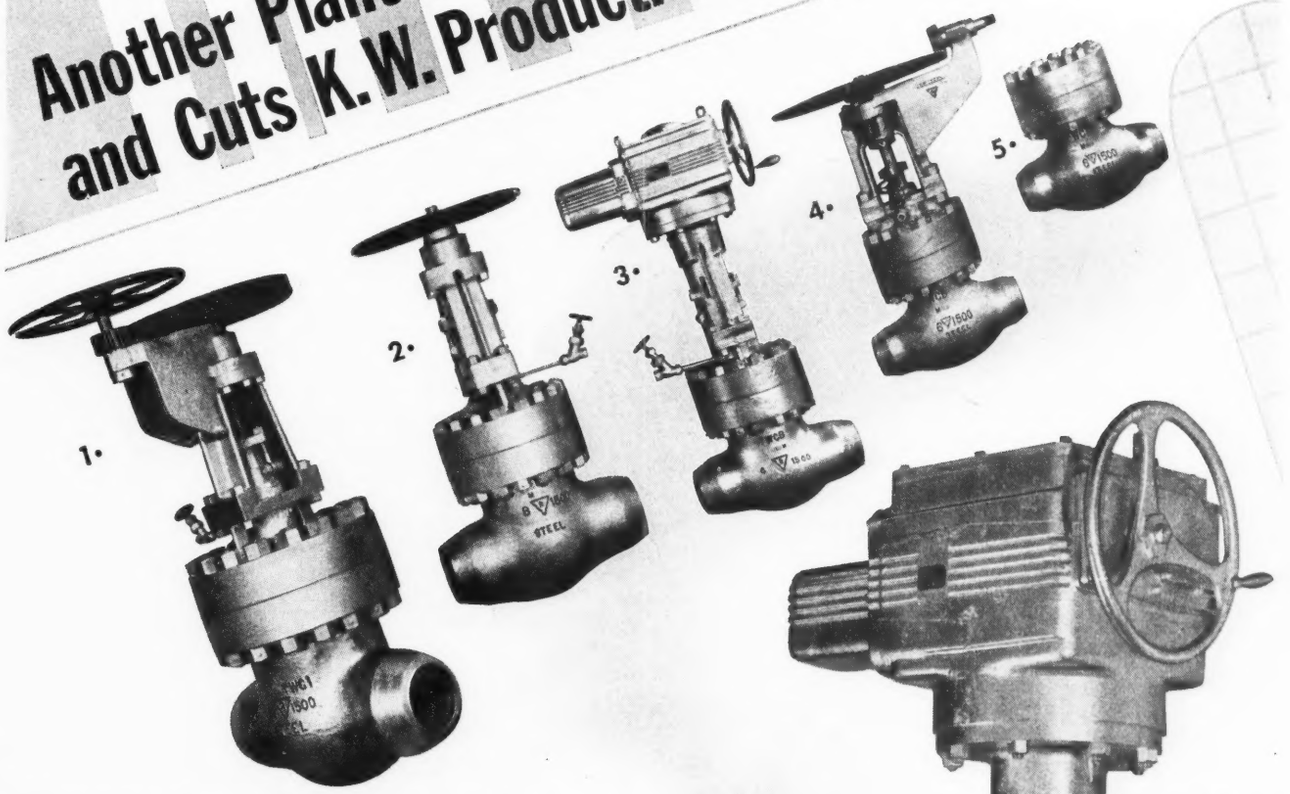
The voltage of the outside source of power was not stated, but whether or not power transformers are required, we know that before the feeder is connected to the oil circuit breaker the voltage must be equal to the bus voltage which is 2500 volts, 60 cycle, 3 phase. Potential and current transformers must then be connected to this source for feeding the various meters, relays, etc.

After the installation is completed, the phase relation and phase rotating of the incoming power must be checked against that of the plant. The phase rotation can be checked by closing the incoming feeder on a dead section of the station bus. After the bus has thus been energized,



use this source of supply to start one of the station three phase induction motors and check its direction of rotation; if the motor rotation is correct, this indicates that the incoming power has the same phase rotation as the generators. If the motor rotation is reversed, it will be necessary to interchange two of the feeder phase wires. Next, cut in the synchronism indicator between this same bus and the incoming feeder. The pointer should stand on the in-phase position; if it indicates out of phase, the potential transformer leads are either reversed or have been connected across the wrong phase wires. When the synchronism indicator shows in phase, and the motor rotates in

Another Plant *UPs* Capacity and Cuts K.W. Production Costs

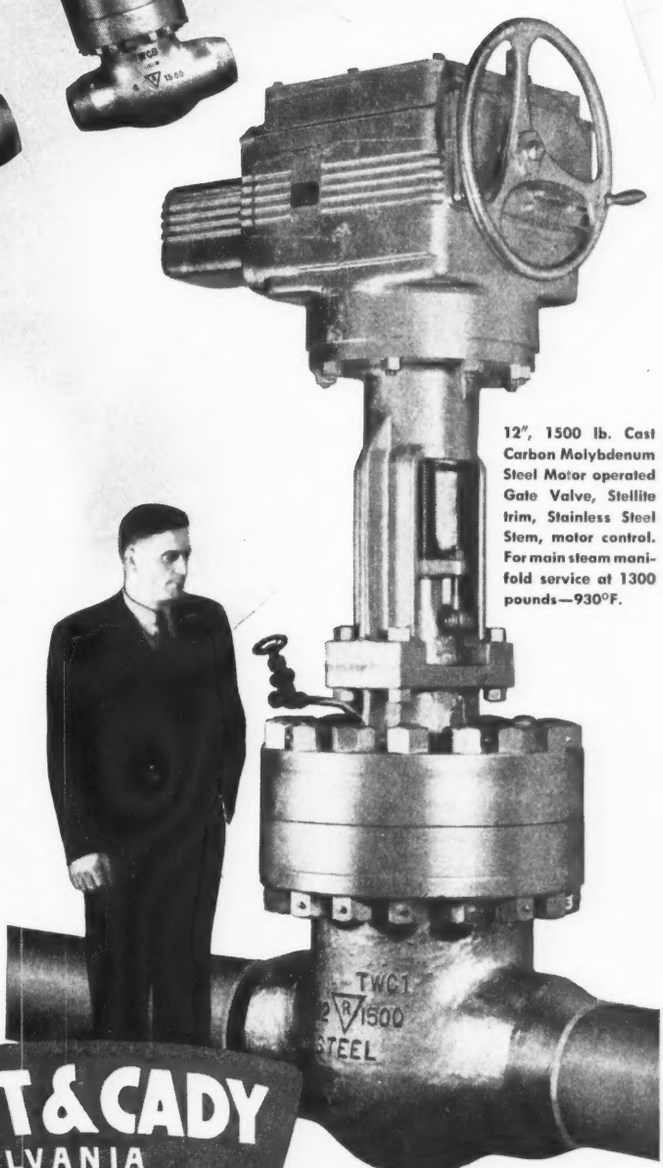


Farsighted planning readied this plant for today's stepped-up demand. And it might well be of interest to Engineers and Plant operators that, as part of this program, Reading-Pratt & Cady valves were installed to handle the high temperatures and pressures called for by its Engineers.

Five of these are illustrated above—in addition to the modern, motor operated, 12-inch, 1500 lb. Steel Gate Valve at the right.

1. **12", 1500 lb. Spur Gear operated carbon moly Steel Gate Valve, Stellite trim. For steam service at 1300 lbs. pressure, 930°F.**
2. **8", 1500 lb. Cast Steel Gate Valve, Stainless Steel Stem, Stellite trim with special condensing chamber drain. For main boiler feed service.**
3. **6", 1500 lb. Cast Steel Gate Valve with compensated type motor operator. On boiler feed pump discharge.**
4. **1500 lb. Cast Steel Globe Valve with bevel gear with 1:6 gear ratio for close throttling in auxiliary boiler feed service.**
5. **6", 1500 lb. Lift Check Valve, Stellite trim, Stainless Steel piston and dash pot. On boiler feed pump discharge.**

These installations may suggest that, when Steam Power Plant Valves are up for discussion, you, too, will find it worthwhile to get recommendations from Reading-Pratt & Cady.



12", 1500 lb. Cast Carbon Molybdenum Steel Motor operated Gate Valve, Stellite trim, Stainless Steel Stem, motor control. For main steam manifold service at 1300 pounds—930°F.

READING CAST STEEL VALVES AND FITTINGS
PRATT & CADY BRASS AND IRON VALVES
D'ESTE VALVE AND ENGINEERING SPECIALTIES

READING-PRATT & CADY
READING, PENNSYLVANIA

A *Division of* AMERICAN CHAIN & CABLE COMPANY, INC.

VALVE RESEATING MACHINES ARE NEEDED IN *EVERY* PLANT

With your plants working on a 24-hour basis you cannot afford any steam waste through leakage.

The Improved Dexter Valve Reseating Machine for reseating Globe Valves, Gate Valves and for refacing Pump Valve seats will save steam loss and save "shut downs."

Due to the increased demand for valve replacements are you going to be able to get all the sizes, types, etc., you need? Dexter Valve Reseating Equipment will eliminate all this worry and trouble. All this can be done with a comparatively small investment that will pay for itself year after year.

Can you afford to overlook this saving proposition?

WRITE NOW FOR OUR NEW CATALOG 40

THE LEAVITT MACHINE CO.

10 East River St. Orange, Mass.

its normal direction, the phase relation and phase rotation of the incoming source is similar to that of the station generators. Cut the feeder out, energize the station bus from the generators, equalize the frequency and voltage of the plant with that of the outside source, and the two systems are ready to be paralleled when the synchronism indicator pointer shows the system to be in phase.

Before attempting to parallel for the first time it might be judicious to wait until the plant load requirements could be carried on one station generator. A better plan would be to use a separate station bus and parallel an unloaded generator with the incoming feeder, the governor and voltage regulator operation could then be checked and necessary changes made without interfering with the plant power supply. In this way valuable operating experience could be acquired by watching the behavior of this generator. If this operation proved satisfactory the incoming feeder could then be paralleled with the rest of the station.

Operating under this condition, the voltage regulator attempting to hold a steady voltage on the bus will increase or decrease the generator field current, which will vary the amount of reactive flowing in or out over the incoming feeder.

The generator governors, in attempting to maintain a constant frequency, will be affected by the frequency of the outside system; and as this frequency varies, the generator load will vary, which in turn will change the amount of power flowing in or out over the incoming feeder.

It may be necessary to change the speed droop adjustment on the engine governors to secure satisfactory operation even though their operation was satisfactory under the former set up. It may also be necessary to reset the limits or make other adjustments to the voltage regulator. The governors, and voltage regulator, will attempt to correct frequency and voltage even though the need for this correction is due to load variations on the outside system. The capacity of the main outside distribution feeder and the regulation of the outside system will affect the plant to a great extent in regards to holding a constant load on the generators, as well as voltage regulation in the plant.

The intended parallel operation may work smoothly from the start and again it may be necessary to do considerable experimenting with the governors and regulator before a setting can be found which will give satisfactory operation. No information was given in the question as to the capacity of the plant, or of the proposed tie feeder, so we must assume that the proposed tie will be designed with sufficient stability to hold the two systems in parallel. Proper design of this feeder is necessary if the two systems are to be stable, and operate without falling out of step.

Conestoga, Pa. E W FELLER

Voltage Regulator Trouble

THE MINIMUM REQUIREMENT for operation in parallel with a utility service would be a switchboard panel with an oil circuit

The ACCURACY of the NULL BALANCE METHOD

. . universally recognized as the most accurate means of measuring a force or quantity

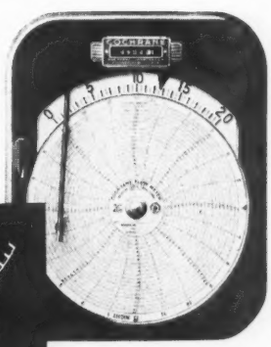
Weighing gold and silver bars on precision beam balances at U. S. Mint.

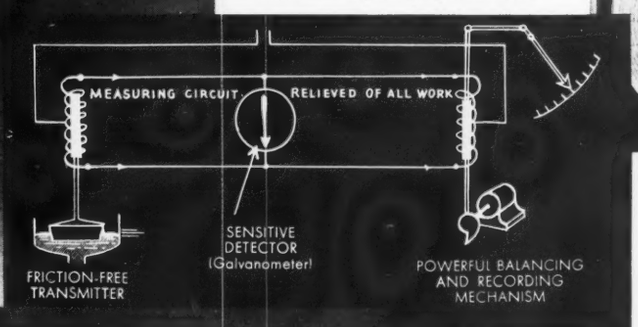
THE great beam balances used in the mints of most of the nations of the world to measure the precious gold and silver of coinage, exemplify the extreme accuracy that is built into the Cochrane Flow Meter. For the Cochrane Flow Meter makes use of this same principle of balancing the unknown quantity by adjusting against it a known quantity of the same kind. A highly sensitive indicator is used to detect the point of balance.

The diagram shown below illustrates how this is accomplished. The frictionless float merely acts as a pilot (through a sensitive galvanometer) for a powerful EXTERNAL source of power which relieves the float and measuring circuit of all work.

COCHRANE ACCURACY IS GUARANTEED

Because of its freedom from friction and its high and equal power throughout the scale, the accuracy of every Cochrane Flow Meter is explicitly guaranteed.





One of the big precision beam balances at the U. S. Mint, Philadelphia.

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A visual presentation on the subject of flow metering in general (and also in particular) will be submitted for your personal inspection if you will write the Cochrane Corporation, 3106 N. 17th St., Philadelphia, Pa.

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breaker of ample interrupting capacity for the maximum current that could be delivered to the tie line. The breaker should also be provided with overload trip coils, preferably operated with overcurrent relays fed from the secondaries of a pair of current transformers connected to the same phase of the tie line that the synchronizing receptacles on the generator panels are connected. This transformer should be arranged to supply a set of voltmeter and synchronizing receptacles.

The question does not state the terms under which the power is to be purchased but it would be desirable to provide an alternating-current ammeter with a transfer switch for connecting it in any of the phases of the tie line. If the rate contains a demand clause, a polyphase indicating wattmeter with an additional potential transformer is useful but unless this meter can be watched closely, some form of control relay which will operate the engine governors to limit the load on the line will be necessary.

If the utility plant is large compared to the one in question, it will be impossible to use the voltage regulator, as the smaller generators could not effect sufficient change in the voltage to cause the regulator to operate. Therefore it will stand in the maximum raise or lower position according to the utility voltage. Possibly the regulator could be connected to maintain unity power factor in the tie line, which would be desirable if the contract contains a power-factor clause.

Altoona, Pa. A R MARKLAND

Learn the Power-Company Requirements

THE PROBLEM OF FES IS GOVERNED by the requirements of the source from which the power is to be purchased, and the equipment supplied by the power company. Provision must be made to tie the new source of power to the station through an oil switch. Metering equipment is sometimes installed and maintained by the company supplying the power, at its expense. Reverse-current protection will no doubt be required to prevent the generators from feeding into the line in case of line failure. Overload protection will also be needed to prevent the line from feeding into a station fault. Some disconnecting device must be added ahead of the oil switch to permit connecting potential transformer, phasing out, and other operation while the line is dead.

The phase sequence, or phase rotation, of the station and purchased power must be the same. In other words, it is not only necessary that one phase of the generator be in synchronism with one phase of the purchased power, but the sequence of maximum voltages must be the same in all phases. This can be checked with lamps in the secondary of the potential transformers, which no doubt, would be done by the power company. The first time it will be necessary to have the synchronizing lamps in two phases go bright and dark at the same time. After

For Safety **at the Water Gauge**

When Open . . . .

the Everlasting Water Column Valve provides a straight through unimpeded passageway. The fact that the valve is open is visible at a glance, and a lock on the open indicator prevents accidental closing.

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the record of the Everlasting Valve assures the operator of a leak-tight closure so that a new gauge glass can be installed without the necessity for protection of the operator's face and hands from escaping steam or water.

For pressures 250-lb. and less, made of bronze composition. Supplied in sizes 1¼-in. and 1½-in., screwed and flanged. For pressures above 250-lb. and up to 600-lb. made of cast steel with discs and seat faces of special alloy. Supplied in 1½-in. size with flanged ends.

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A POINT WORTH ENLARGING—TO HELP YOU BUY WELDING FITTINGS WISELY!

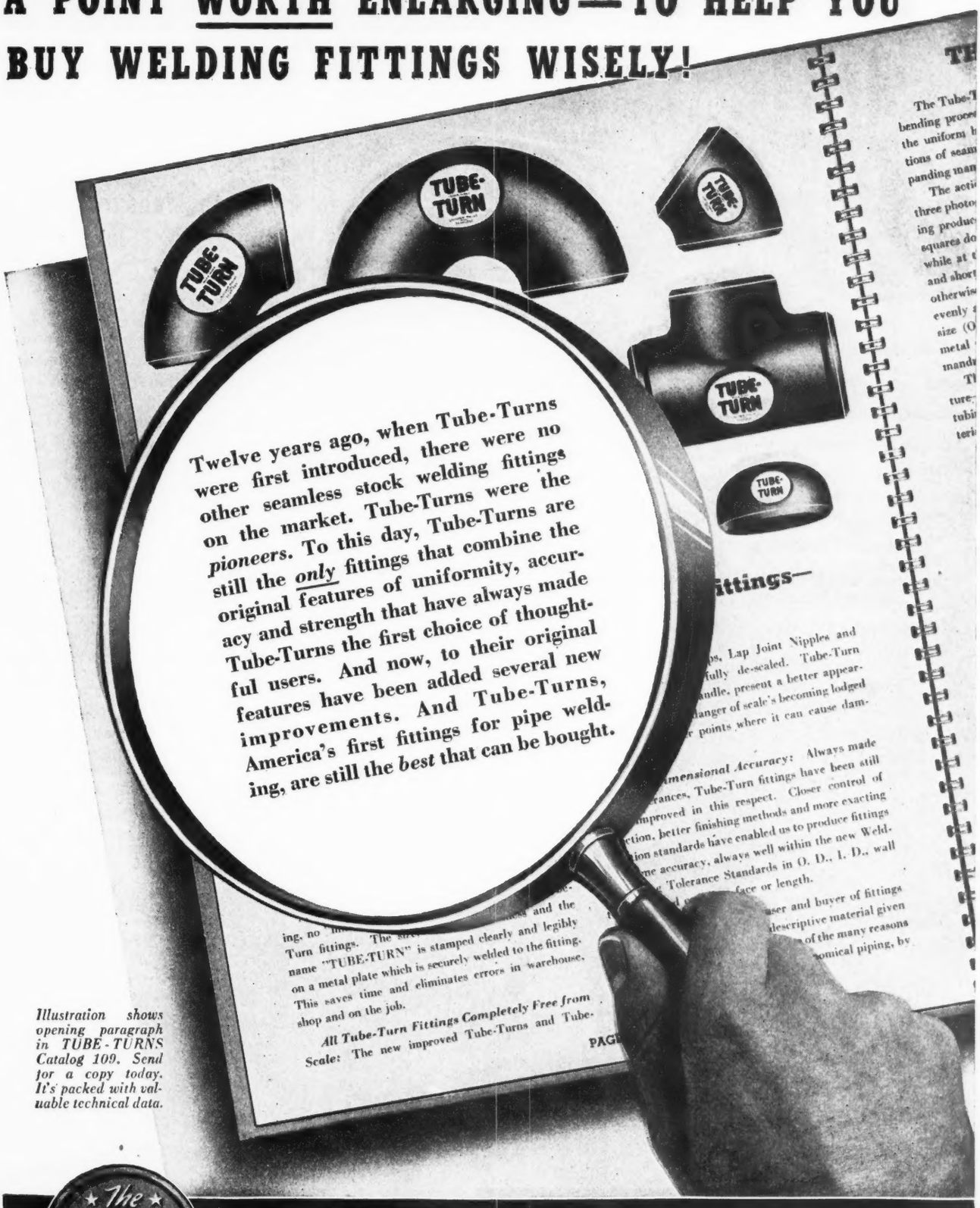
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Illustration shows opening paragraph in TUBE-TURNS Catalog 109. Send for a copy today. It's packed with valuable technical data.

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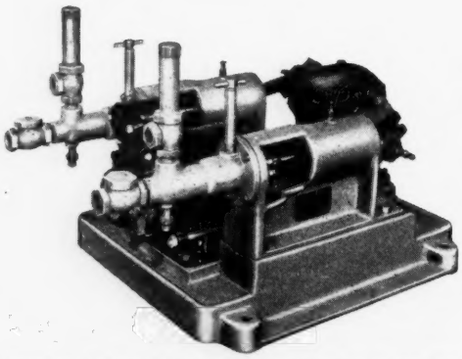
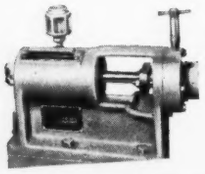
Complete chemical treating and feeding methods for the power plant include the handling of phosphates, sulphites, sulphates, sulphuric acid, etc. by:

1. Constant rate Adjust-O-Feeder for low and high pressure service.
2. Shot feed Adjust-O-Feeder with manually adjustable time cycle control.
3. Flow-proportional Adjust-O-Feeder or Treet-O-Unit with control from—(a) reciprocating boiler feed pumps—(b) electric motor-driven control from either mechanical or Venturi meters.



Standard Adjust-O-Feeder for pressures up to 250 lbs. Capacities from 5 gph. to 10 gpm.

The accuracy and performance of a proportioning pump depend on these features:



Cross head guide with visible stroke length scale.

Micrometer crank arm with adjusting screw.

Connecting rod assembly showing needle bearings.

Use %Proportioneers% Chemical Feeders for general plant water supply; and deaerator treatment for direct feed to boiler drums. Send for Bulletin SM 122A

% PROPORTIONEERS, INC. %

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this only one set of lamp, or the synchroscope, is all that is needed.

My recommendation to FES is that he get the requirements of the power company then install one new panel for the incoming line with the oil switch voltmeter synchronizing receptacle, and any equipment they might require.

Wilmette, Ill. E O SCHMOKER

Accurate Measurement of Pulsating Flow

By WILLIAM MELAS

Engineer, Cochran Corp

▶ PULSATING FLOW is generally encountered in systems where reciprocating engines, pumps, and compressors are used. The intermittent action of such units creates pressure and velocity waves in the fluid, whether it be liquid or gaseous. These waves or pulsations increase flowmeter readings, not because of oscillation of the pen back and forth on the chart, but because of the inability of the recorder to follow each pulsation accurately. Precautions may be taken, however, to reduce the pulsations to where they will cause only small errors in the readings.

The errors which result from pulsating flow may be explained by the following example: Assume a steam flowmeter with a maximum capacity of 10,000 lb per hr and that the flow pulsates so that at one instant the differential pressure is 48 in. of water and the next instant 3 in. Flow corresponding to 48 in. head will be 8000 lb per hr; for 3 in. it will be 2000 lb per hr. Inertia of the fluid in piping and of the mercury in the instrument prevents the recorder from following the quick changes in differential, and it takes a position corresponding to the average differential of 25.5 in., registering 5800 lb per hr. However, with flow for half the time at 8000 lb per hr and for the other half 2000, average flow is 5000 lb per hr. Therefore, in this case pulsating flow causes the recorder to read 16% high.

Inaccuracies due to pulsating flow may be greater or less than that given in the example, since the magnitude of the error depends upon the frequency and degree of pulsation, volume and other characteristics of the piping and compressibility of the fluid. In any case, it is important that pulsations be dampened or eliminated in order to measure the flow accurately.

The hookup, Fig. 1, enables a flowmeter to measure accurately water taken by a reciprocating pump from an open feedwater heater or other re-

What price Boiler Shutdowns ?

● You know only too well the cost of boiler shutdowns due to setting failures.

Frequent loss of boiler service may have serious and far-reaching consequences in these turbulent days when all equipment is being pushed to capacity to meet production demands.

You can definitely correct this situation by installing "Carbofrax", the Carborundum Brand Silicon Carbide Refractory, in your boiler furnaces. "Carbofrax" will give you dependable service—long life—freedom from clinker troubles resulting in full grate capacity. "Carbofrax" will withstand severest boiler furnace conditions because of its outstanding refractoriness and resistance to spalling and cracking.

A "Carbofrax" setting is a dependable setting.

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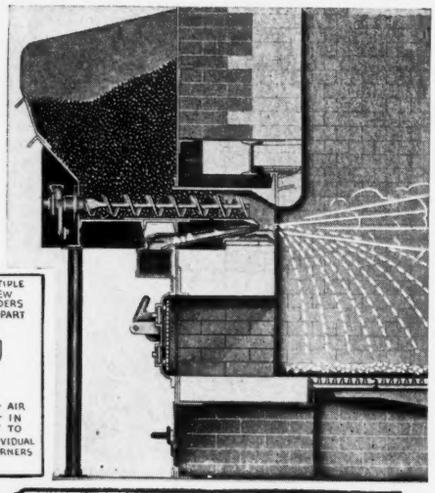
7. HIGH QUALITY CONSTRUCTION. We will be glad to supply you with detailed information about FYR-FEEDER units. Write today. The coupon below is for your convenience.

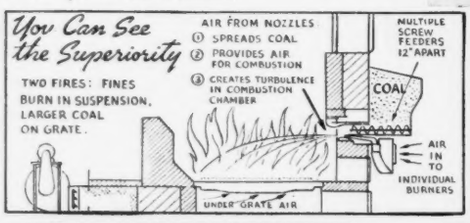
—writes CLARENCE M. SIEBEN, *Chief Engineer,* SIEBEN'S BREWERY CO., Chicago, Ill.

From letter: "Your FYR-FEEDER system of burning cheap coal, installed under one of our 250 H.P. boilers and replacing an underfeed type of stoker, has reduced our coal bill from $4000 to $2500 annually.

"This annual saving of $1500 not only exceeded your own estimate, but permitted us to pay out our investment in the FYR-FEEDER in about 18 months after it was placed in service. We now burn yard sweepings, also the smaller, cheaper sizes of coal ranging from $1.50 to $2.00 less per ton than the coal required by our former method of firing; also, we now automatically maintain uniform steam pressure under all loads, and the FYR-FEEDER gives us higher efficiency, in addition to the direct saving in the price of coal."

—A 74% Return on the Investment!

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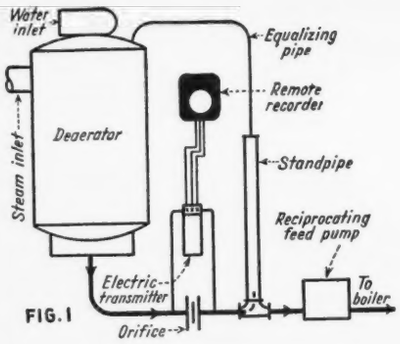

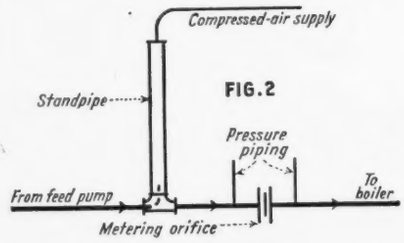

Fig. 1—Standpipe on reciprocating-pump suction permits accurate recording by flowmeter. Fig. 2—Compressed air in standpipe absorbs pulsations from discharge of reciprocating pump. Fig. 3—Throttling orifices dampen pulsations when metering steam, air or gas

ceptacle having a free water surface. A stand-pipe between the pump and the orifice, vented back to the heater, absorbs the pulsations created by the pump. While the standpipe water level rises and falls, due to the pulsations, flow through the orifice remains fairly constant and allows the meter to respond to a head corresponding to the average flow. Where it is impracticable to vent the standpipe back to the heater it may be supplied with compressed air.

When lack of pressure head or other conditions prohibit the orifice being placed on the suction side of the pump, the orifice may be placed on the discharge side, and the standpipe connected to a source of compressed air, Fig. 2. Pulsations of the water flow cause the compressed air to contract and expand alternately in the standpipe and they are thus absorbed, making it possible for the flowmeter to measure the flow accurately. This arrangement is also suitable for measuring liquids other than water.

When measuring a compressible fluid such as steam, air or gas, satisfactory results may be attained by installing sufficient receiver capacity and causing the fluid to undergo one or more abrupt velocity changes. This

...Short-Changed BY A BOILER?

Making steam is a business transaction. You pay a certain sum for fuel and water, from which you expect to get a proportionate amount of steam. In a deal like this, it is all too easy to receive short change.

Scale on a boiler's heating surface causes a direct drop in heat transfer with corresponding loss of efficiency and fuel. As little as one-sixteenth inch of scale may cause a loss of as much as thirteen per cent in heat units paid for, but not received.

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Accurate readings (within 3/10 of 1% CO_2) in 30 seconds.

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No chemical or fragile parts to get out of order. Operates on lighting circuit.

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Big savings on fuel costs reported by users—as high as 20%.

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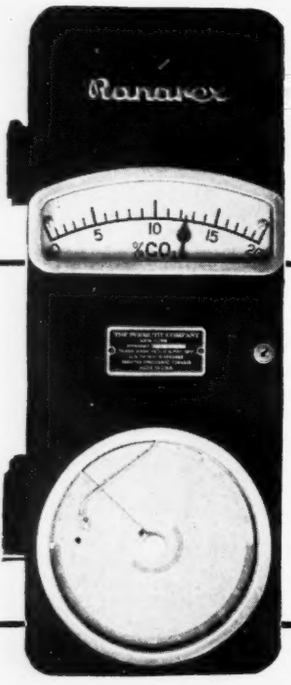


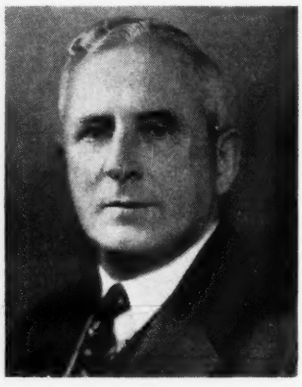
product of

PERMUTIT

allows the fluid to compress and expand in the receiver space and consequently dampens out the pulsations. If a large receiver is not available, throttling orifices, Fig. 3, may be used to produce changes in velocity. These orifices may be constructed of thin sheet metal and inserted between flanges in the line. This method results in a pressure loss which is not recoverable, and, therefore use of a receiver may sometimes be preferable. Neither of these methods can be used for measuring water or other liquids, since they are practically incompressible.

Boston Edison Co Personnel Changes

Warren E Kennedy, chief engineer of Steam Stations since 1931, Boston Edison Co, has recently resigned. He entered the employ of Boston Edison in 1900, leaving three years later to join General Electric Co in Schenectady for a period of 13 years. Mr. Kennedy rejoined Boston Edison in 1916 as assistant chief engineer of Steam Stations.



Warren E. Kennedy

Richard Brown

Richard Brown, successor to Mr Kennedy as chief engineer of Steam

UNSHAKO

Reg. U. S. Pat. Office

SELF-LOCKING NUT

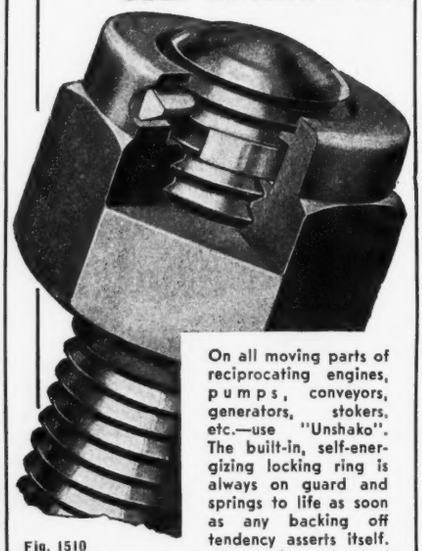


Fig. 1510
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On all moving parts of reciprocating engines, pumps, conveyors, generators, stokers, etc.—use "Unshako". The built-in, self-energizing locking ring is always on guard and springs to life as soon as any backing off tendency asserts itself. *It's real protection!* For details, write—

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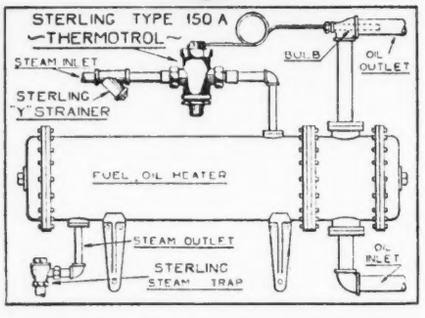

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I Keep Generator Voltage Steady!"

HERE'S the modern way to assure smooth, steady generator voltage at all times—with G-E DIACTOR regulators. Their accurate, *automatic* operation squashes voltage bumps almost before they start.

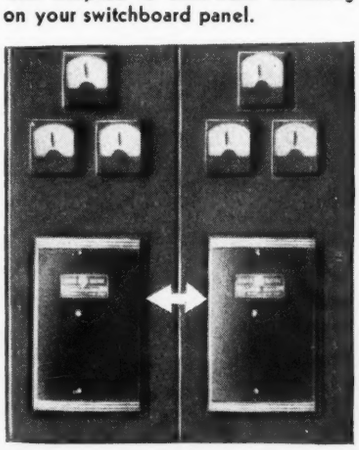
Voltmeters quiet down and voltage worries end when a wide-range DIACTOR regulator goes on the job. This compact little fellow holds the voltage close to the desired value quite simply; after a change in operating conditions, he quickly returns the voltage to normal without hunting or instability. And because of the simple, reliable design (all parts are normally stationary), you needn't worry about bothersome, costly maintenance, or continual re-adjusting.

Here are some of the more important features of these regulators:

Direct acting—fast in operation
Electrically damped—no dashpots
No vibrating contacts—for reliability and long life
Simple construction—only six leads required
Low in price—starting at $70 list

Whether your problem is one of replacing old regulating equipment, or involves a completely new installation, there's a DIACTOR generator-voltage regulator exactly suited to your needs. A specialist in the nearest G-E office will be glad to give you complete information. General Electric, Schenectady, N. Y.

Streamlined DIACTOR regulators are well adapted to semi-flush mounting on your switchboard panel.



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It can happen in your plant . . . *and probably has!*

He's a swell fellow, good wireman, does a neat job, and he'd think you were kidding if you told him he was throwing a monkey wrench into production . . . but he may be doing just that *without realizing it* every time he runs control, power or lighting circuits anywhere near steam lines, boilers, furnaces, ovens or other hot spots.

It's guess-work and *the wrong wire* that paves the way for many of the tie-ups that clog production. What's hot to one man isn't so hot to another. Ambient and operating temperatures that seem safe when the wire is installed are boosted 'way up by summer heat, overloads, and hot spots. The insulation dries out, becomes brittle, cracks, and then . . . failures, delays and rewiring that might have been avoided.

1. Rockbestos A.V.C. Boiler Room and Lighting Wire
2. Rockbestos A.V.C. Power Cable
3. Rockbestos All-Asbestos Power and Rheostat Cable

Numbers 1 and 2, Underwriters' and N.E. Code–Type AVA–operating temperature 230°F., number 3, Type AI, operating temperature 257°F.

You can outguess the thermometer and have a wide margin of safety with Rockbestos *permanently insulated* wires. They are resistant to heat, fire, moisture, oil, grease and fumes, approved by the Underwriters' Laboratories and recognized in the National Electrical Code. More than one hundred different constructions to select from. Send for a catalog. Rockbestos Products Corporation, 998 Nicoll St., New Haven, Conn.

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Also refer to McGraw-Hill Electrical Buyers Reference.

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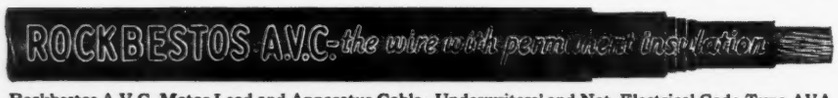

Rockbestos A.V.C. Motor Lead and Apparatus Cable–Underwriters' and Nat. Electrical Code Type AVA –one of 118 different permanently insulated wires.

Stations, has served as Mr Kennedy's assistant since 1931. Mr Brown entered the Boston Edison employ in 1924 as head of the Mechanical-Technical Div, Production Dept. Before that, he was employed on production work for the Worcester Electric Light Co.

Thomas M Burton, new assistant chief engineer of Steam Stations, has been with Boston Edison since 1916. He has served in various capacities on production work, starting as a watch engineer, and since 1929 has been assistant chief engineer of the Steam Div at the company's L Street generating plant in South Boston.

Oscar B Benson, who has been named assistant chief of Electrical Operations in charge of Substations, Boston Edison Co, completes 30 years of continuous service in that utility's employ this month. From 1919 to 1937 he was head of the Battery Div, Production Dept, responsible for all storage battery equipment used to back up the direct-current system of downtown Boston in emergency. In 1937 he was made head of the Direct-Current Substations Div.

Hartford, Rochester to Add New Units

Capacity of the South Meadow plant of the Hartford Electric Light Co will be increased to 175,000 kw with installation of a 45,000-kw turbine-generator now being built by General Electric Co. Present output of the station is 130,000 kw.

The new unit is similar to the machine installed in September, 1938. It will be a tandem-compound, double-flow turbine with hydrogen-cooled generator. Steam conditions will be 850 lb, 900 F.

Installation of a 25,000-kw turbine-generator, now being built, and a 15,000-kw unit, nearing completion, will bring the generating capacity of Rochester Gas & Electric Co's No. 3 station over 140,000 kw. A duplicate of the turbine-generator installed in September, 1938, the latest unit, a General Electric machine, will generate 25,000 kw at 650 lb, 825 F. The turbine will be tandem-compound, double-flow with hydrogen-cooled generator.

Warren Webster & Co, Camden, N. J., has purchased the Ross expansion joint business from the Ross Heater & Mfg Co, of Buffalo, N. Y., to supplement its line of conventional Webster expansion joints. The Ross company is continuing with all of its other lines.